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# INDIAN FORESTER

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## DEPARTMENTAL EXPLOITATION IN THE WESTERN HIMALAYAS.

1. The following pamphlet has been prepared for the guidance of Forest Officers in charge of departmental exploitation. It summarizes all the experience of past years; and work carried out in the manner indicated will be found to proceed both smoothly and efficiently. The haphazard felling and sawing of trees is always attended with avoidable loss; the sawyer is not an expert axeman and no proper supervision of the felling is possible when this work proceeds throughout the working season from day to day as the trees may be required. It is highly desirable to keep the operations of fellings, sawing and carriage entirely distinct and only in this way is the maximum efficiency obtained.

2. The trees having been marked, they are felled by a special gang of fellers who are paid a fixed rate according to the size of the trees. An extra payment is made for branching where

this is necessary. In certain cases a felling rope must also be used but extra is paid for this. At present the felling is done entirely with the axe but efforts should be made to introduce felling with the saw as is done in England. After much trouble the standard of felling in Kulu and Bashahr is now good, much better than under former departmental working and this high standard must be maintained. The felled trees should all lie the same way parallel to one another and should not be felled across one another; on steep ground with little ridges and gullies the trees must be felled straight uphill and not across the gullies, otherwise there will be a heavy loss in breakage. It is essential that a trained subordinate who is competent to direct the fall of every tree be in charge of this work and that he should be made responsible for having the work done in accordance with the Divisional standing orders. The man in charge of the work is supplied with a copy of the marking list and has to tick off every tree as it is felled. Only one man is allowed to fell one tree with the axe. Using two men on the same tree should generally be avoided; but when using the saw two men may work together in partnership.

3. When all the trees have been felled the forest is divided up among the various sawing mates or contractors according to the amount of labour which they command, and the various carriage-leads are chained out by a responsible officer and their rates fixed. These ghals as they are called are then given out to the carriage mates. It is generally a mistake to give sawing and carriage to the same contractor.

All logging of all species must be done with cross-cut saws which are provided for the purpose, the axeing of logs is absolutely prohibited and any workmen found doing this should be fined forthwith. The contractor and the official in charge of the work will be furnished with a list of sizes to be sawn. As the scantlings are sawn up they will be stacked by the sawyers until they are passed by the forest official in charge of the work. All scantlings passed will be hammer-marked with the Government property mark, entered in the passing register with the signature

of the sawing and carriage mates and brought on to form No. 7 (Forest depôt). They are then to be carried down to the launching depôt, counted, struck off from the forest depôt and entered up under the launching depôt where they remain until launching begins. Sleepers are carried by coolies but it is impossible to carry beams and these are dragged along properly constructed dragging paths by means of a rope and a spike fixed into the beam. These dragging paths are paved with poles or branch wood so that the beams slide along easily and do not dig holes in the ground with their ends. Before the floating men arrive and launching takes place a launching list must be prepared by the official in charge of the work and this launching list must be checked by the Divisional Officer or some official deputed by him. Any scantlings which may arrive at the launching depôt after the list has been prepared are to be separately stacked and entered in a supplementary launching list before being launched. The floating contractor will satisfy himself that the launching list is correct and will sign a receipt that he has received the timber entered in the list; after he has done this launching may begin. All payments and all prior entries of timber in account forms must be agreed with the launching list which is the final check.

4. The floating contractor in Kulu is allowed a maximum loss of five per cent. of deodar and is made to pay the value of anything lost in excess of this. He is also only paid for what he delivers at the catching depôt. Rafting from the catching depôt to the sale depôt is generally a separate contract.

5. Wet slides are used for transporting scantlings from the forest to the river *or down nalas.* These slides are constructed as in the sketch overleaf and are either made of the B. G. Sleepers or beams being extracted or where it is not desired to lock up for some years the large capital represented by the scantlings in the slide, fir planks may be used. The cost of such slides is about Rs. 1,000 a mile. The construction is similar in both cases.

Neither nails nor spikes are used; the scantlings or boards simply rest on the sleepers or trestles and are kept firmly in their places by means of wedges, the beams being caulked with moss.

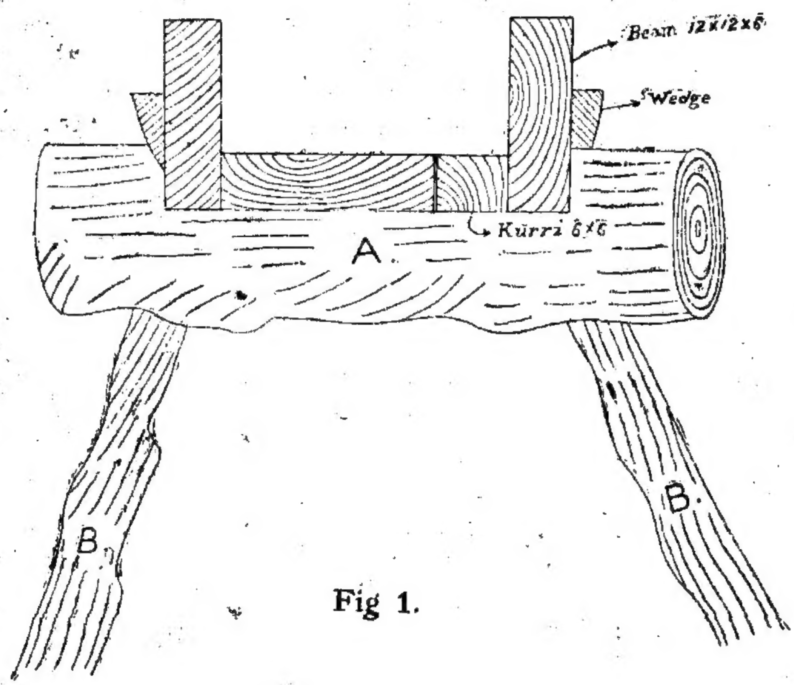



Fig 1.

The head of the trestle A commonly called the 'sikanja' consists of a rough round log of fir or hard wood about 2½ feet to 3½ feet long and from 12″ to 15″ in diameter, the size is not of much importance and any refuse suffices for this purpose, but the bed of the slide must be axed out to the right size required, which of course depends on the maximum size of scantling being dealt with. The logs (B B) are rough poles of fir or other wood some 3″ in diameter at the upper end, let into the head, and spread outwards, so as to give rigidity to the structure. Ordinarily the trough is laid so that each section is complete in itself; and a trestle of the kind above described is placed under each point of junction of the successive sections which compose it. An intermediate trestle may be placed in midway between each pair of main trestles where this extra support is necessary; and where the logs of the trestles are very long so that the trough is raised high above the ground or where the slide crosses a stream the

scantlings composing the slide are made to 'break joint,' the bottom scantlings meeting over each main trestle and the sides over each intermediate trestle. At curves the outer edge of the trough is laid higher than the inner edge so as to diminish the force with which the descending sleeper strikes the outer side joint. The pace at which the sleeper travels is much effected by the quantity of water in the slide; it descends faster than the water which in steep places is thrown out before it so that if the quantity of water be increased the pace at which the sleeper descends is proportionally reduced. Pools to maintain the supply of water must be provided about every quarter of a mile. When launching is in progress a couple men with boat hooks are stationed at each pool and then pass the sleepers on to the next section of the slide. These slides lead direct to the river or to the launching point in some side stream. The gradient of these slides varies from nearly dead level to a fall of 40 in 100; but this slope can only be used for very short distances otherwise a bad accident will result.

*Log Works.*

6. The extraction of logs will now be considered; this work was extensively carried out in Chamba and Bashahr in the past and it is probable that departmental log works will again be started. *As this work has almost been forgotten it has been thought* fit to give some description of the methods adopted in past times.

Log works were brought to a fine art in Bashahr and Chamba from 1880 to 1900 after which they declined in importance. It may safely be said that no timber extraction work of the present day can be compared to the Bekani slide in Chamba, a description and illustration of which will be found on page 328 of Schlich's Manual of Forestry, Volume V.

7. After logging the trees the logs are worked down by rolling and by the use of wooden levers until they reach a prepared way, such as a rolling road, an earth slide, or a dry wooden slide, down which they are passed to the bank of the river or other destination.

The rolling road is employed when the slope of the hillside is moderate. Such a road is sometimes constructed round the hill

immediately below the forest so that the logs may be worked down to it from where they lie and may then be rolled along it to the site of the mill or the head of a slide. It is also used in places where the route of the logs on their way to the river or mill follows the bank of a ravine or the top of a precipice.

The road, which is from 14 to 18 feet wide, has a fall of not more than 10°. It is commenced by laying a row of large stones as at (A) in figure 2, and above them rough logs of wood of various kinds, or brushwood, obtained by the clearance of the line of

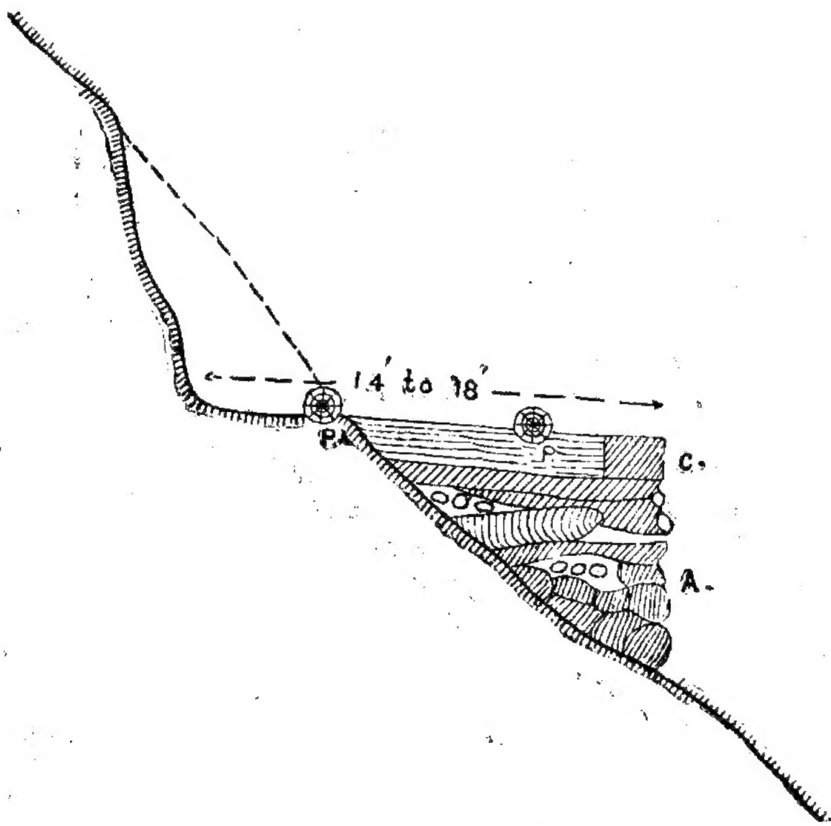



Fig 2. Rolling road

road through the forest. It is found that logs or brushwood are far preferable to stones for this purpose, as they are better able to stand the shock of the rolling timber. A coping (C) of rough stone is added at the outer edge of the roadway, and the earth from the cutting is thrown down so as to give a horizontal cross section. On this poles (P, P) are laid like rails on a railroad and down them the logs are slowly rolled, a few feet at a time, by means of wooden levers. Should the route lie across a small ravine or a hollow, the latter is entirely filled up with logs, brushwood and stones, or it is bridged by a rough structure of logs with poles laid across them so as to form the roadway. The cost of such road nowadays would probably be from Rs. 10 to Rs. 20 per hundred running feet.

8. The earth slide is simply a natural hollow or drainage channel improved so that logs can be worked down it endwise by the aid of levers. This method is apt to do considerable damage to the hillsides especially in wet weather and caution is necessary in working it. The fall should not as a rule exceed 25° otherwise the logs get out of control ; check walls are erected at intervals if there is a possibility of this happening. Check walls are constructed as follows. At a selected point in the earth slide a terrace, which may be from 20 feet to 70 feet long and from 15 feet to 30 feet wide, is cut out of the hillside. On its outer edge, a row of logs (A, A, A) in figure 3 of some 18 feet in length is planted perpendicularly to the direction of the slide, the logs being from 6 feet to 8 feet apart, and having about one-third of their length buried. Behind them is erected a roughly constructed wood and stone wall from 10 feet to 20 feet wide at the top, and about 6 feet to 10 feet high on the inner side. The wall rests on a foundation of solid earth cut out to receive it. Sometimes the outer face of the wall is supported by a second row of logs, the spaces between them being filled up with rough poles and other pieces of wood so as to hold the stones firmly, and thus to prevent them being displaced by the shock of the falling logs. If the floor of the terrace be hard, it is usually sunk to a depth of some 4 or 5 feet and the hollow thus

formed (B) is filled with loose soil or brushwood so as to check the fall of the logs and thus arrest them, or at any rate so as to

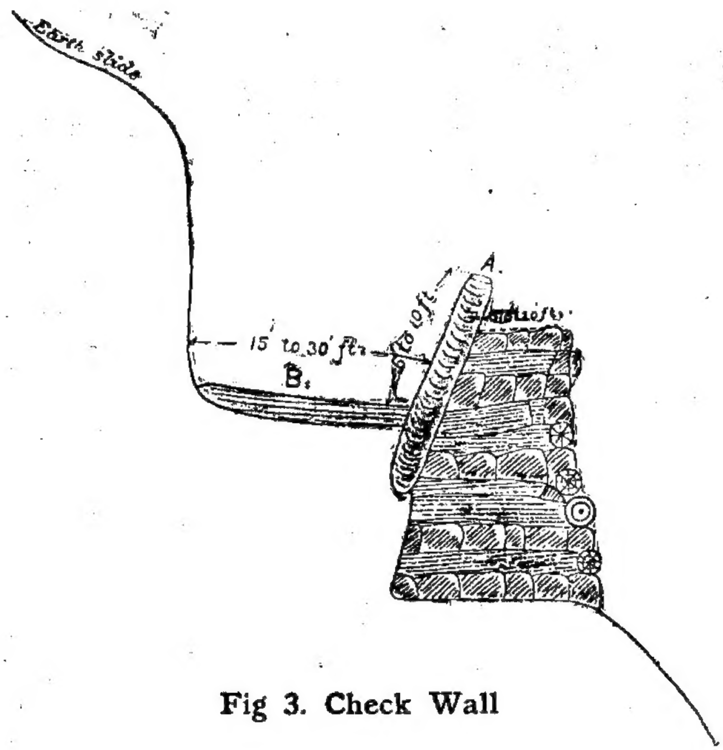



**Fig 3. Check Wall**

moderate the force with which they strike the wall. The logs are then moved by levers to the head of the next section of the earth slide. On very steep slopes where check walls are required at short intervals it is not always possible to find places at which their foundation can be laid. In such cases a partial check is afforded by simply driving in a row of iron jumpers into the ground, to support a line of logs laid horizontally above them. Such obstacles, being much lower than an ordinary check wall, must obviously be placed nearer together than would be necessary were such walls employed. Check walls may be expected to cost about Rs. 3 per hundred cubic feet of walling.

The dry wooden log slide is usually employed when the route of the logs lies across the hill slopes or in localities where the ground is either very rocky and difficult to clear for an earth slide or where it crosses over or at the edge of cultivated fields. It is composed, in section of five logs or three tops (A, A, b, b, c) of figure 4 so disposed as to make a roughly made trough. The two larger pieces (A, A) lying at the outside, are about 5½ feet in girth, the inner logs or poles being smaller, the ends of these timbers rest on a roughly made round sleeper (S) to which they

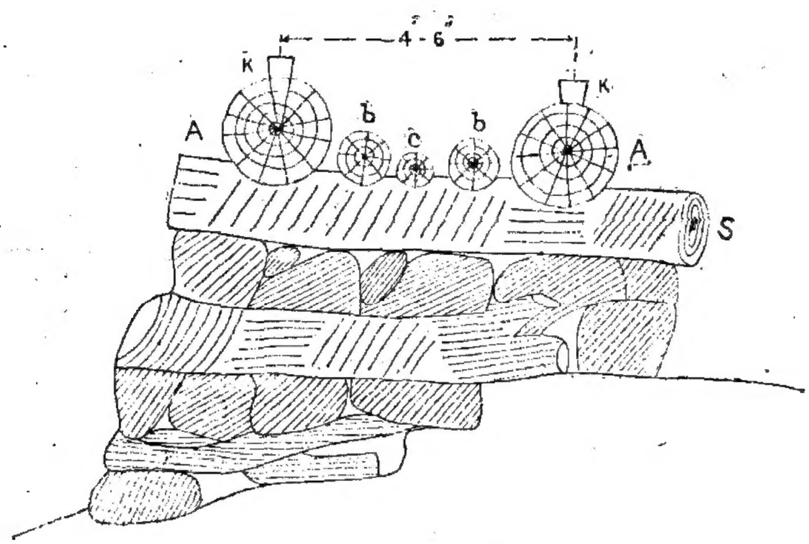



Fig 4.

are pinned down by a spike of hard wood (K, K). The tendency of the timbers to slip forward when the slide is in use is further checked by their being hollowed out below, so as to lock themselves on to the sleeper (fig. 5) which also shows the method of joining the timbers composing the slide. A sufficient gradient must be given to the slide so that the logs will travel nicely; this will be obtained from gradients of 15° to 25°. *If the fall is* as much as 30° exceptional precautions must be taken to avoid accidents.

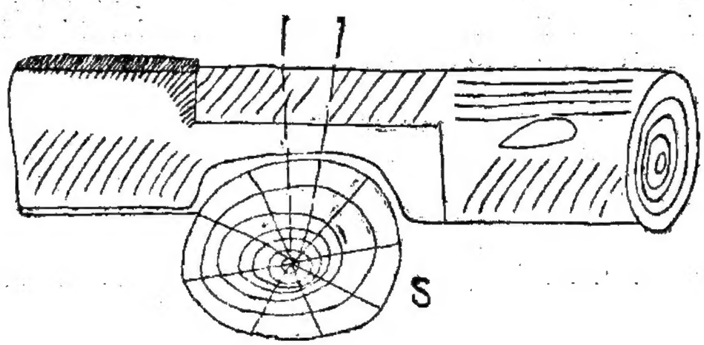



Fig 5.

ROPEWAYS.

9. Simple wire ropeways are used for the extraction of scantlings in difficult ground, or when the carriage labour supply is deficient.

The form of ropeways used in Bashahr is that patented by Mr. C. H. Donald under the name "The Timber Carrier" Indian Patent Nos. 334 of 1912 and 1064 of 1913. For full details of materials, methods of erections, and working, his pamphlet should be consulted.

Briefly stated the ropeway in common use consists of three parallel wires, fixed at the upper end and at the lower end attached to a baulk of timber, which can be rotated by wooden levers in order to tighten the ropes. The load is carried by these ropes to which it is attached by pulleys which are also attached to an endless control rope running round two vertical pulleys. A brake acts on the lower pulley in order to prevent the load descending too quickly.

The main advantages of this particular form of ropeway are its cheapness, portability, and simplicity. It can be erected for the carriage of a few thousand sleepers and can be controlled by ordinary unskilled labour in charge of a capable mate or munshi.

The ordinary span is from 2,000 to 3,000 feet and spans longer than 3,000 feet are not recommended. Loads up to 8 cubic

feet of timber are easily carried and stronger materials might allow of heavier loads. A load of 8 cubic feet of timber allows of the extraction of beams that can otherwise only be extracted by dragging or by wooden timber slides.

The price of all ropeway materials has risen considerably on account of the war and the cost of extraction has therefore considerably increased; there is, however, a very considerable saving in actual cost of carriage, and when combined with the facts that beams can easily be carried in precipitous ground and that the labour required for the carriage is very considerably reduced, the advantage of ropeways in remote and precipitous forests is established.

Generally speaking, in easy ground, it is cheaper to use an ordinary timber slide.

# NOTES ON A VISIT TO THE PINDÂRI GLACIER, KUMAON.

BY H. G. CHAMPION AND W. J. LAMBERT.

No one is likely to be stationed long in the Almora district without being tempted sooner or later to go up to the Pindari glacier, especially as a line of dâk bungalows specially built many years ago to facilitate the trip, enables one to travel both quickly and lightly. Visitors usually go up either shor tly before the rains in June, or after them in October, the former being the best time for some of the more familiar flowers such as the primroses and the upper red Rhododendron *(R. barbatum)*, and the latter for others such as the gentians and alpine composites, and also presenting the advantage of greater freedom from snow. The choice of July *for our trip was partly due to the fact that both seasons are rather* inconvenient to the forest officer, but also to our desire to see what we could in a few days of the high level flora under rains conditions, and to avoid "the rush."

A few lines about the local physiography are necessary to elucidate the notes which follow—notes which are modified from an entry made in the log-book maintained at the last bungalow. The Pindar River takes its rise from a series of moderate sized glaciers on the south side of the great snowy ridge running more

or less east and west through the well-known E. Trisul, to the beautiful Bankattia peak (22,530′), usually misnamed Nandakot. The uppermost four glaciers lie in the Almora district, the east central one being the Pindari proper, and the most easterly the Kaphini glacier, whilst the water of the other western two (known as Sukaram and Maiktoli and visited by one of the writers in 1919) forms the Sunderdhunga River, which runs south to join the Pindar a little below Kathi bungalow.

The route from Almora or Ranikhet follows up the Sarju River from Bageswar for two marches to Loharkhet, whence it crosses the Sarju-Pindar (*i.e.*, the Sarda-Ganges) watershed into and up the valley of the latter river. The bungalows and their elevations are as follows :—

| | | | | | |
|---|---|---|---|---|---|
| Bageswar | ... 3,200′ | 27 ms. | from | Almora. |
| Kapkot | ... 3,750′ | 41 " | " | " |
| Loharkhet | ... 5,600′ | 49 " | " | " |
| Dhakuri | ... 8,900′ | 55 " | " | " |
| Kathi | ... 7,200′ | 60 " | " | " |
| Dwali | ... 9,000′ | 66 " | " | " |
| Phurkia | ... 10,700′ | 70 " | " | " |

The road ends near Martoli, 4 ms. further on, at 12,275′.

The Sarju valley is largely cultivated, though here and there the chir pine forests come down close to the river, and as the south side of the main watershed ridge has been largely denuded of forest by the village graziers, good forest is only reached after crossing into the Pindar basin. Dhakuri reserve (at this season liable to be alive with leeches), forming a strip some 12 miles long between the ridge and the river, is a very fair sample of the type of forest met with, consisting of a fairly dense crop of kharsu oak (*Quercus semecarpifolia*) with scattered groups of silver fir and hard-woods including maples, walnut, ash, elm, etc., and often a very dense undergrowth of ringals (*Arundinaria*, 4 spp.). In places frequented by graziers, the canopy becomes much broken and species such as *Prunus Padus* predominate : Abies and Taxus are the only conifers. The birch-Rhododendron formation (*B. utilis*

and *R. campanulatum)* is only reached shortly below Phurkia, and beyond and above it comes an ill-defined zone of dwarf aromatic Rhododendrons (*R. Anthopogon* with bright red flowers on more rocky ground, and *R. lepidotum* with pale yellow flowers), with two Junipers (*Juniperus recurva* and *J. Pseudo-sabina*), Lonicera spp., Cassiope, etc. In places, Berberis becomes rather conspicuous, and an attempt to unravel the confusion of the specific individuality of some of the forms, especially round Dwali, gave an added interest to it.

Dwali, at the junction of the Pindari and Kaphini streams, may be considered the starting point of the more interesting country, though not a few nice things may be seen before in the jungle up from Kathi. We reached Dwali on the 12th July, and left it on the return journey on the 18th.

The weather was normal; we expected to get wet and were not disappointed. The 13th was the finest day, a beautiful morning with the snows clear till midday and again clear in the evening; the 18th was very fine right up to 2 P.M. Other days were roughly similar with no rain till about 11 or 12 o'clock, then mist, then rain usually getting progressively heavier and lasting well into the night. Two of the four mornings at Phurkia were sunny but only one with a clear view of the snows.

On each outing made, we collected quantities of plants and insects, the examination and attempted identification of which more than filled up all the spare time we had at the bungalows, but the records collected are mainly of purely local interest, and so are omitted. It may, however, be mentioned that we noted in all 148 different woody plants, and brought up the total of definitely recorded flowering plants to 404 (excluding grasses). Only six species of butterflies were seen, though large numbers of moths came to the lights at night, and though specimens were abundant enough, only some 65 species of beetles were collected, an almost identical lot to those collected the previous year in the Sunderdhunga.

*13th July.*—Dwali to Phurkia; the road in good order with two nalas full of snow, one of them a snow bridge. We went

as far as Martoli in the evening and here too the road was in very good order considering the locality and season; we crossed five nalas full of snow, three of them snow bridges. It was impossible to take ponies much beyond Phurkia.

*14th July.*—A dull morning with mist on the snows, so after breakfast we worked the hillside to the east of the bungalow. Crossing the big nala above the bungalow, we went above the road and along the base of the big precipice there, and found a track (possibly lead-up to a grazing camp) going straight up the hill. Rain began to fall on the way up, but we went on till it became really unpleasant and then returned from 12,425′.

*15th July.*—A fairly fine morning with only the peaks enveloped in mist, so we decided on the regular glacier trip. Times were as follows :—

| | | Out. | Back. |
|---|---|---|---|
| Phurkia ... ... | 10,700′ | 4-30 A.M. | 12-30 P.M. |
| End of road on crest of lateral moraine ... | 12,275′ | 5-50 „ | ... |
| Saddle in left medial moraine ... ... | 13,225′ | 6-50 „ | ... |
| Top of ditto at cliff ... | 13,575′ | 7-5 „ | ... |
| Top of lower ice fall ... | 13,875′ | 7-25 „ | 7-30 A.M. |

We went at a fair pace along the road but lost some time at the big nala near Phurkia, as the snow bridge on the road collapsed during the night of the 14th-15th, necessitating a climb some distance up the hillside; we also had to wait some 5 minutes above Martoli to enable the "guides" to catch up. After leaving the road, we took things very easily. The Nanda Kot glacier appears simply a mass of stones, mud and rubbish, ice, and that very dirty, only appearing at rare intervals; the real glacier is high up towards Nanda Kot. Except for the snow bridges on the road, the only snow crossed was in the last 200—300 yards. While debating whether to go on over the level ice between the ice falls it began to rain, and as we wished to work the flora of the moraine we returned, two chaprasis amusing themselves by going on to the base of the upper ice fall, probably another 700—800′ climb,

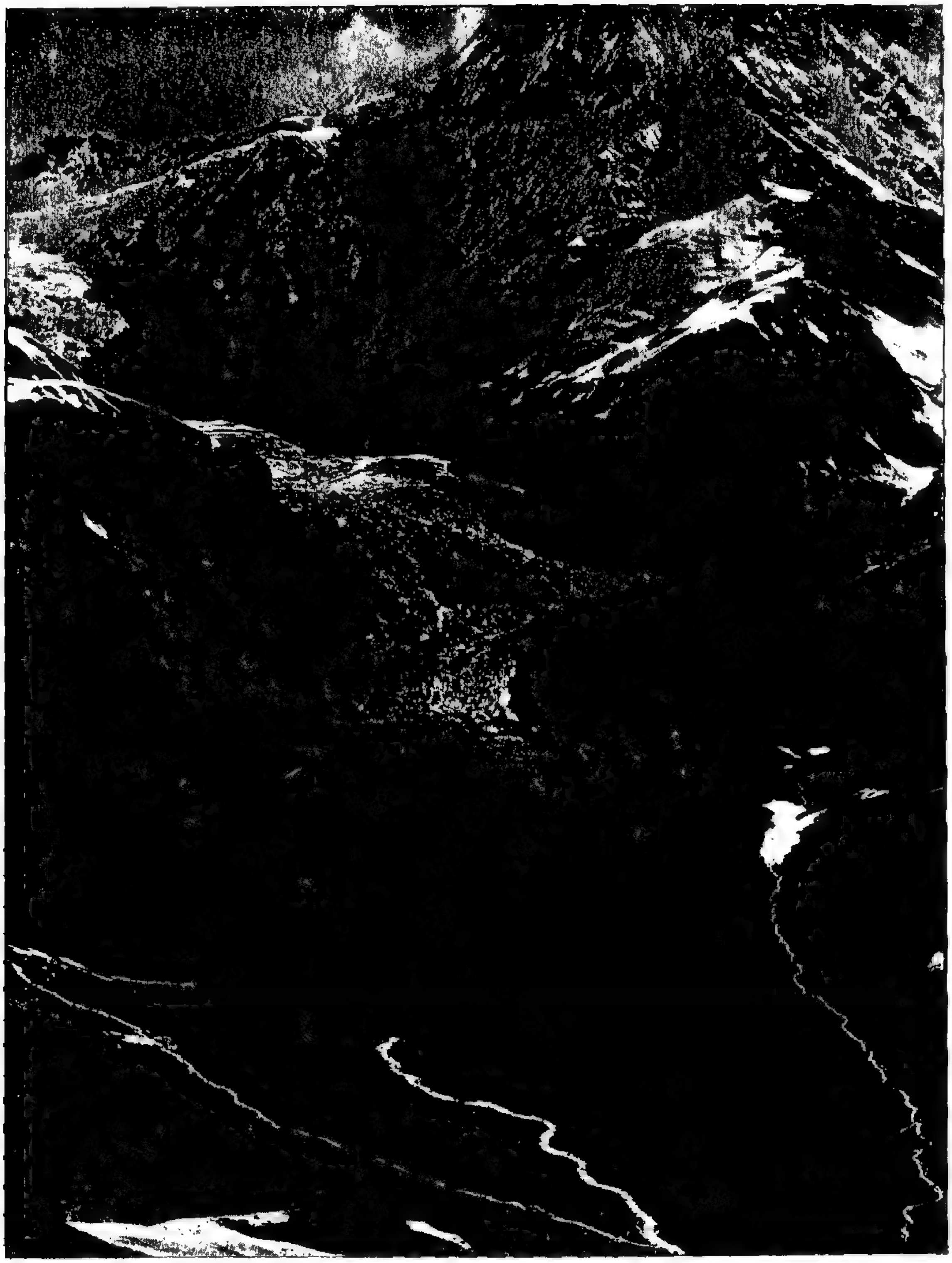
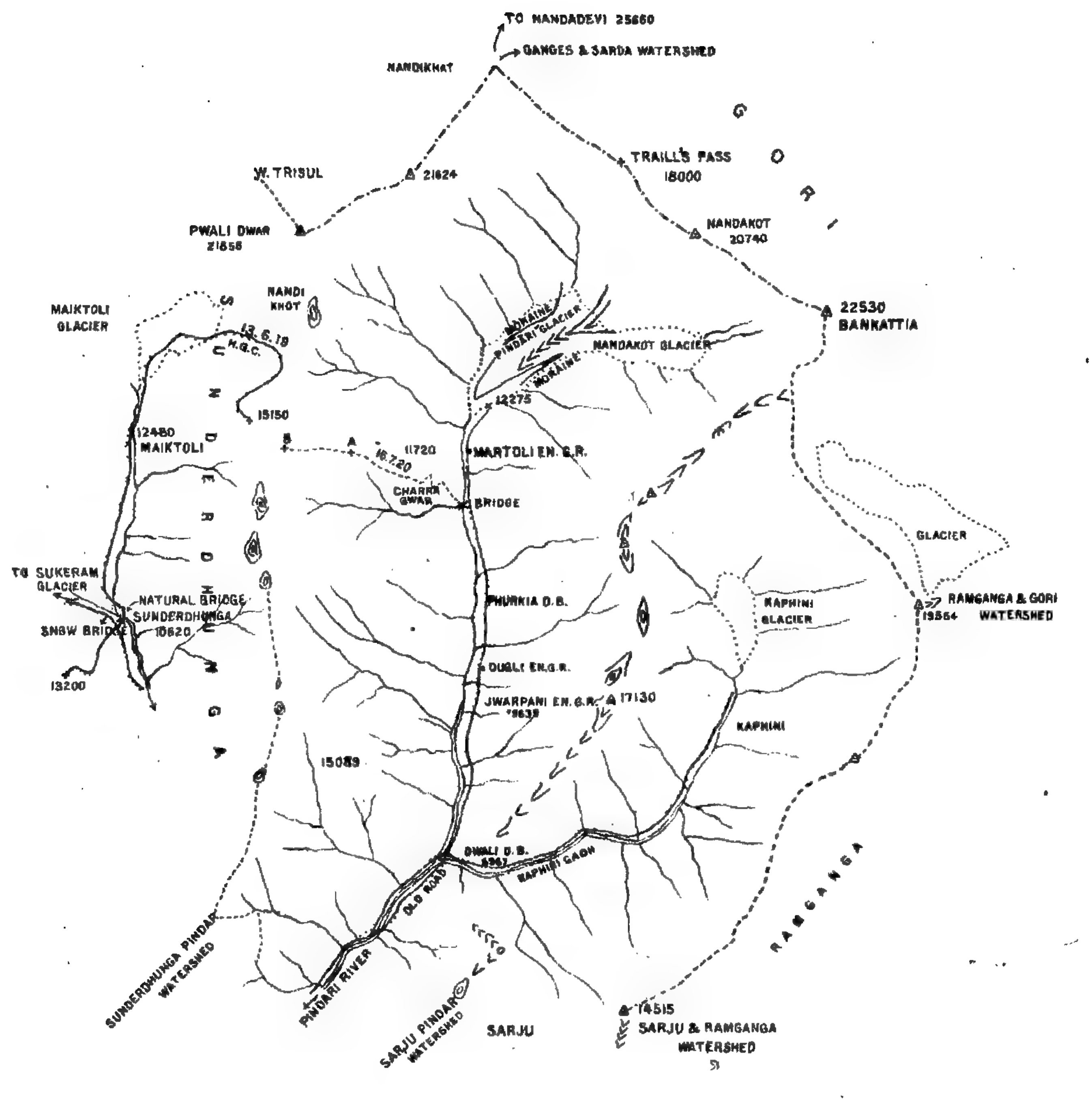
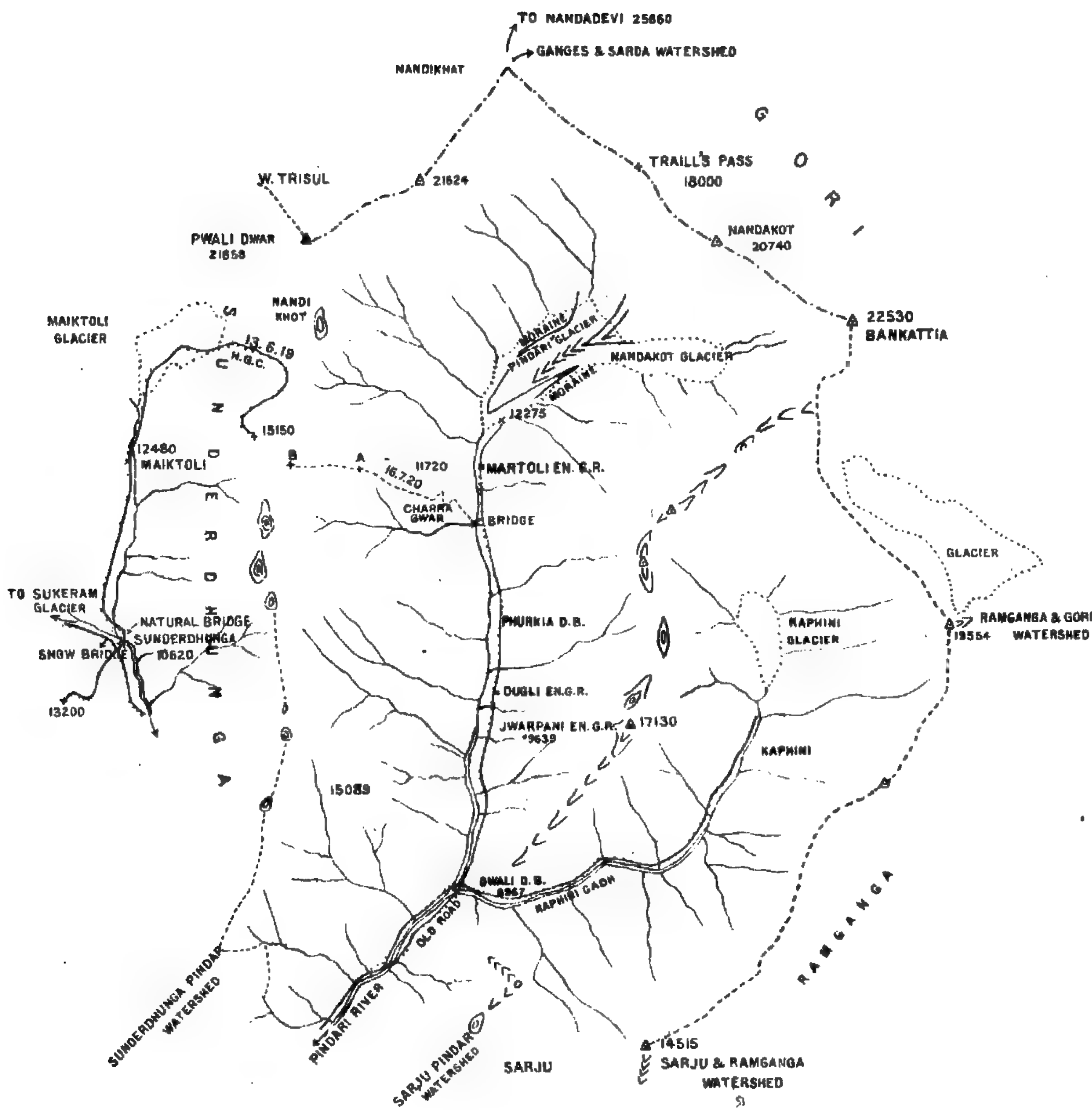


Photo-Mech. Dept. Thomason College, Roorkee. Photo. by W. J. Lambert.

Pindari Glacier.




Scale half an inch to a mile




Scale half an inch to a mile

The height recorded for the top of the lower ice fall—13,875'—agrees well with the 13,850' previously recorded by Mr. Canning; our height for the saddle in the moraine is 225' higher. As the glacier near the snout looked similar to the portion of the Nanda Kot glacier which we had crossed twice, and as the rain was becoming unpleasant, we omitted to visit the snout on the return journey. This is a very easy trip in July for any one accustomed to hill climbing—guides being quite superfluous.

*16th July.*—We had planned an early start with the intention of crossing a kachha bridge we had seen below Martoli, and getting up the western side of the valley. Unfortunately a very misty dawn nearly decided us to postpone the trip; but an hour later it cleared rapidly, and we went off post haste without breakfast along the road to just short of Martoli, then down to the bridge and up through Chhara gwar, and over grassy slopes to a well defined rocky spur (see map made from 1" Survey of India sheets Nos. 246, 247, 254 and 255). One gets a magnificent almost bird's-eye view of both glaciers from about 14,000', and all snow peaks were clear. After stopping to take the photograph, showed in the Frontispiece, we decided to push on to a snow-field visible higher up the spur, and leaving the guides' behind, took on one orderly only. Climbing steadily, and crossing only a few small patches of snow, one reaches a well defined peak on the spur (A on map). From this point begins an almost unbroken, moderately sloped snow-field, running up to precipitous cliffs, below which ice cliffs were showing. Westwards across the snow-field, a large perched block on a spur running down into the snow-field caught our attention, and we decided to push on to this conspicuous landmark (about B on map). The snow was in good condition, with only two or three clear strips of loose stones, and the going comparatively easy. On reaching the block on the spur, the latter was found to be free from snow, and to carry an abundant show of flowers. The spur overlooked a very fine unbroken snow-field, with many protruding ice cliffs. To the N.-W., the lowest visible point on the Sunderdhunga-Pindar watershed, seemed to be about 1,500' above us, only the last 500' of which

would have offered any difficulties. As mist appeared to be gathering, we made a hasty survey of the flora of the spur, and retraced our tracks as quickly as possible to the point A. From here we worked our way down to the bridge, returning roughly by the same route. From the bridge, there is a sheep path for some distance to the road, and then back to the bungalow. Our times were as follows :—

| | Out. | Back. |
|---|---|---|
| Phurkia ... ... | 5-50 A.M. | 1-40 P.M. |
| Bridge ... ... | 6-40 „ | 12-45 „ |
| Point B ... ... | 10-00 „ | 10-15 A.M. |

The aneroid barometer had been damaged the previous day by a fall coming down the medial moraine, and its readings were unfortunately useless. The highest point reached was probably *not* less than 15,500′, and more likely 16,000′.

*17th July.*—We worked round the bungalow, and on the opposite side of the river, crossing by a frail snow bridge and returning to Dwali in the evening.

*18th July.*—Though once more the weather appeared very unpromising at dawn, it rapidly cleared, and the day ultimately turned out a perfect one till about 2-30, when the usual drizzle began. Leaving Dwali at 5-30, we followed the Kaphini Gadh to the glacier at its head. The track is somewhat rough, but quite easy to follow except in the graziers' camping grounds where it becomes obscured by the rank growth of dock and nettles which characterizes these places. The first couple of miles is through forest; after this the valley opens out a good deal and the gradient lessens, and the route lies mainly over open grazing grounds: these latter appear to be of better quality than those at the head of the Pindar, and more intensively used, to the detriment of the tree and shrub growth. No snow was met with till within about a mile of the glacier, when a large snow bridge was crossed, nor is there any snow in the neighbourhood of the snout.

The following notes about the glacier were made on the spot, the chief feature is the general symmetry, the ice descending almost straight in a southerly direction from an extensive snow-field

in front of Bankattia peak. There is relatively little snow on the flanking slopes, and although there is a certain amount of ice on the left side, it does not join up as a glacier with the main stream. The snout has no ice cave, but a steep unbroken ice cliff descends to within a foot of the issuing water. Owing to the narrow valley, there is very little moraine, that on the right being represented only by a short narrow strip running down from opposite the present snout, and that on the left, although fairly clear, not large; the ice mentioned on the rocky mass on the left has also formed small lateral moraines, but these hardly affect the general outline. The main ice fall is practically unbroken with the exception of one shelf about one-third of the way up. From the foot of the fall to the snout is about ⅓ mile, of gently sloping, débris covered ice, practically free from crevasses, and now carrying but little old snow. The fall appears quite impossible to negotiate on the left, although on the right it might be possible with proper appliances to reach the shelf mentioned. Above the ice fall, appears the top of Bankattia peak, with a very different outline from that seen from the Pindari; it is very picturesque viewed from lower down valley, but less so from the glacier itself. We climbed up some 500′ above the snout on the right side on to a rocky ridge commanding an excellent view of the ice fall, etc., and then returned leisurely to Dwali by the same route.

Our times were as follows, aneroid readings being again useless :—

| | Out. | Back. |
|---|---|---|
| Dwali ... ... | 5-35 A.M. | 2-00 P.M. |
| Khati ... ... | 7-00 ,, | ... |
| Kaphini devta ... | 7-45 ,, | ... |
| Snout ... ... | 8-25 ,, | ... |
| Final point ... ... | 9-00 ,, | 9-30 A.M. |

GENERAL NOTES.

It seems strange that no visitors have remarked on the number and beauty of the waterfalls above Dwali; this is possibly due to a lack of visitors during the rains.

It may interest lovers of dogs to know that a spaniel "Bob" accompanied us on the trip of the 16th, and still more remarkable a second spaniel, "Dandy," left behind at Phurkia because he appeared seedy, suddenly put in an appearance above point A on the map, having followed our tracks from the bungalow, braving the rickety bridge across the Pindar and several fierce sheep dogs guarding the Chhara gwar. Much against his will, we left him with the chaprasi at the point where he joined us until our return.

The following plants of general interest may be mentioned :—

*Corylus Colurna*—closely allied to English hazel.
*Ulmus Wallichiana*— do. do. elm.
*Taxus baccata*—the English yew.
*Syringa Emodi*—a species of lilac.
*Hippophæ salicifolia*—closely allied to sea buckthorn.
*Lilium giganteum*—with flowers up to 6″ long.

As regards the more showy flowers, the following may be recorded as indicating what are to be seen in July :—

### Maximum Flowering.

*Anemone* (3 spp.), most other *Ranunculaceæ*, such as—
*Caltha*, *Trollius*, *Isopyrum*, *Oxygraphis*, etc.
*Meconopsis* (big blue or yellow poppies).
*Corydalis* (several spp.).
*Megacarpæa* (a big conspicuous Crucifer).
*Viola biflora*.
*Saxifraga* (several spp.).
*Rhododendron lepidotum* and *Anthopogon*.
*Primula sibirica* (pale lilac) and *reidii* (cream).
*Androsace* (tufted primrose).
*Cypripedium cordigerum* and other orchids.
*Lilium giganteum* and other less conspicuous *Liliaceæ*.
*Fritillaria oxypetala* (yellow).
*Arisæma*—(several spp.).

### Past Maximum Flowering.

*Pæonia*.
*Spiræa* spp.

*Rosa* (2 spp.).
*Rhododendron campanulatum, barbatum* and *arboreum*.
*Primula denticulata* and *Stuartii* (except at high elevations).
*Cypripedium himalaicum* (yellow).
*Iris kumaonensis*.

NOW APPEARING.

*Thalictrum* spp.
*Geranium* spp.
*Sedum* spp.
*Morina longifolia*.
*Aster* spp., and other composites.
*Boraginaceæ*, several spp.
*Pedicularis*, spp.

NOT YET FLOWERING.

*Aconitum* spp.
*Impatiens* spp.
*Gentiana* spp.

The following plants were noted on the medial moraine :—

SHRUBS.

*Berberis brachybotrys*.
*Myricaria germanica*.
*Astragalus Royleanus*.
*Cotoneaster microphylla* (? var. *glacialis*).
*Lonicera obovata*.
*Cassiope fastigiata*.
*Rhododendron Anthopogon*.
*Salix elegans*.
*S. hastata*.
*S. Lindleyana* (and var. *microphylla*).
*S. fruticulosa*.
*Ephedra Gerardiana*.
*Juniperus recurva*.
*J. Pseudo-sabina*.
*Gaultheria trichophylla* was almost certainly overlooked

HERBS.

*Anemone polyanthes.*
*Trollius acaulis.*
*Arabis alpina.*
*Sisymbrium ? himalaicum.*
*Trigonella corniculata.*
*Parochetus communis.*
*Oxytropis lapponica.*
*Potentilla Sibbaldi.*
*P. Mooniana.*
*P. argyrophylla*, var. *atrosanguinea.*
*Parnassia pusilla.*
*Saxifraga flagellaris.*
*Sedum elongatum.*
*S. ramulosum.*
*Primula denticulata.*
*P. Stuartii.*
*P. sibirica.*
*Androsace sarmentosa.*
*A. Chamæjasme.*
*A. ? globifera.*
*Gentiana capitata.*
*Macrotomia Benthami.*
*Pedicularis* sp. ?.
*Thymus Serpyllum.*

The following plants were noted on the spur "B" of the map, he highest point reached :—

*Callianthemum cachemirianum.*
*Draba ? gracillima.*
*Potentilla sericea.*
*P. microphylla.*
*P. purpurea.*
*P. Sibbaldi*, var. *microphylla.*
*Saxifraga imbricata.*
*S. hemisphærica.*
*S. ? flagellaris*, var. *stenophylla.*

*Sedum asiaticum.*
*? Erigeron alpinus*, var. *uniflora.*
*? Inula obtusifolia.*
*Primula denticulata.*
*P. Stuartii.*
*P.* sp. ? (dwarf).
*Androsace ? globifera.*
*Gentiana capitata*, var. *strobiliforme.*
*Lloydia serotina.*
*Trigonotis rotundifolia.*
*Pedicularis* sp. ?

# THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C. F. C. BEESON, M.A., I.F.S., F.E.S., FOREST ZOOLOGIST.

PART V.

(*Continued from* Indian Forester, *September* 1919, *pp.* 488—495.)

## PLATYPODIDÆ.

**Crossotarsus bonvouloiri**, Chapuis.

Shothole borer.—*Shorea robusta.*

Distribution.—[Cambodia; Sumatra]; Buxa, Jalpaiguri, Bengal.

**Crossotarsus coniferæ**, Stebbing.

Shothole borer.—*Cedrus Deodara, Picea Morinda.*

Distribution.—[Jaunsar, U. P.; Tehri Garhwal; Chamba]; Kashmir; Bashahr, Rawalpindi, Punjab.

**Crossotarsus fairmairei**, Chapuis.

Shothole borer.—*Pinus excelsa.*

Distribution.—[Kashmir]; Jaunsar, West Almora, U. P.

**Crossotarsus fairmairei**, Chapuis, **wilmoti**, Stebbing.

Shothole borer.—*Quercus incana.*

Distribution.—[Jaunsar]; West Almora, U. P.

**Crossotarsus minax**, Walker.

Shothole borer.—*Terminalia belerica.*

Distribution.—[Ceylon]; North Kanara, Bombay.

**Crossotarsus saundersi**, Chapuis.

Shothole borer.—*Buchanania latifolia, Cassia Fistula, Heritiera Fomes, Odina Wodier, Shorea robusta, Shorea Talura*[64], *Terminalia tomentosa.*

Distribution.—[Celebes, Borneo]; Dehra Dun, Siwaliks, Lansdowne, Gonda, Gorakhpur, U. P.; Buxa, Jalpaiguri, Darjeeling, Tista, Sunderbans, Bengal; Goalpara, Nowgong, Assam; S. Mandla, C. P.; Shevaroys, N. Coimbatore, Madras; S. Coorg.

**Crossotarsus squamulatus**, Chapuis.[65]

Shothole borer.—*Heritiera Fomes, Tectona grandis.*

Distribution.—[Java; Borneo; Singapore]; Sunderbans, Bengal; Shwegu, Bhamo, S. Shan States, Burma.

**Diapus aculeatus**, Blandford.

Shothole borer.—*Quercus incana, Quercus semecarpifolia.*

Distribution.—[Japan]; Kangra, Punjab; W. Almora, U. P.

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[64] *Diapus taluræ*, Stebbing, is a composite species, based on 3 specimens bearing identical labels "Talamalai Reserve, N. Coimbatore, Madras, ex Shorea Talura, 6. VIII. 1902, E. P. S." Two of these, on one pin, are *Crossotarsus saundersi*, Chapuis, ♂, ♀ and the third is an immature ♂ *Diapus furtivus*, Sampson. The original description (Dept. Notes, I (1906), pp. 418-419) is based mainly on the third specimen, but the sexual differences are referred to the 2 specimens of *saundersi*. The illustrations accompanying the description (*l. c.*, plate XXIV, figs. 4a, 4b ♀ ♂, lege ♂ ♀!) are of *Crossotarsus saundersi*, Chap. In 1914 (Indian Forest Insects, pp. 626-627) the original definition is reproduced *verbatim* under *Platypus taluræ*, Stebbing, together with fig. 396 = *Crossotarsus saundersi*, Chap. ♂. By application of the law of priority the *saundersi* component of the composite species is removed and the third specimen becomes the type. In the meantime Winn Sampson (Ann. Mag. Nat Hist., (8), xii, 1913, pp. 450-452) described *Diapus furtivus*, to which Stebbing's species as now restricted, must fall as a synonym.

*Diapus taluræ*, Stebbing (1906) = *Crossotarsus saundersi*, Chap. (1866) + *Diapus furtivus*, Samps. (19 3).

[65] The index to the Review of Applied Entomology, Vol. VI, A, 1918, incorrectly records this species from *Shorea robusta*; in the original paper the host tree is *Heritiera Fomes*.—C. F. C. B.

**Diapus capillatus**, Sampson.

Shothole borer.—*Quercus lamellosa.*

Distribution.—[Darjeeling, Bengal.]

**Diapus furtivus**, Sampson.

Shothole borer.—*Shorea robusta, Shorea Talura.*

Distribution.—Dehra Dun, Siwaliks, Lansdowne, Kheri, Ramnagar, Gonda, Gorakhpur, U. P.; Jalpaiguri, Buxa, Tista, Darjeeling, Kalimpong, Bengal; Goalpara, Nowgong, Garo Hills, Assam; Porahat, Bihar and Orissa; S. Mandla, S. Raipur, C. P.; N. Coimbatore, Madras.

**Diapus impressus**, Janson.

Shothole borer.—*Alnus nepalensis, Quercus incana, Quercus semecarpifolia.*

Distribution.—[Jaunsar]; W. Almora, U. P.

**Diapus quadrispinatus**, Chapuis[66].

Shothole borer.—*Alnus nepalensis.*

Distribution.—[Ind. Orient]; W. Almora, U. P.; Darjeeling, Bengal.

**Diapus quinquespinatus**, Chapuis.

Shothole borer.—*Shorea robusta.*

Distribution.—[Java; Celebes, Borneo; Morty Isles; N. Guinea]; Jalpaiguri, Buxa, Bengal; Goalpara, Garo Hills, Assam.

**Platypus biformis**, Chapuis.

Shothole borer.—*Pinus longifolia.*

Distribution.—[Darjeeling ?]; Rawalpindi, Kangra, Punjab; Chamba; Jaunsar, N. and S. Garhwal, C. Almora, Ranikhet, Naini Tal, U. P.

**Platypus cupulatus**, Chapuis.

Shothole borer —*Terminalia belerica.*

Distribution.—[Borneo; Java; Sumatra; Malay Peninsula; Tenasserim; Burma; Andaman Isles; Nilgiris, Madras].

[66] Figs. 13, 13a, and 14 of Plate 9, Genera Insectorum, Platypodidæ are of *D. quadrispinatus*, Chap. and not of *quinquespinatus*, Chap. as labelled.—C. F. C. B.

**Platypus cupulifer,** Wichmann.

Shothole borer.—*Shorea robusta.*

Distribution.—[Arbor-land; Dibrugarh, Assam]; Jalpaiguri, Buxa, Bengal.

**Platypus curtus,** Chapuis.

Shothole borer.—*Shorea robusta.*

Distribution.—[Borneo; Singapore]; Buxa, Jalpaiguri, Bengal; Goalpara, Darrang, Assam.

**Platypus falcatus,** Strohmeyer.

Shothole borer.—*Alnus nepalensis.*

Distribution.—[Kulu, Punjab]; W. Almora, U. P.

**Platypus indicus,** Strohmeyer.

Shothole borer.—*Artocarpus integrifolia, Tetrameles nudiflora.*

Distribution.—[Nilgiris, Madras]; S. Malabar, Madras.

**Platypus rectangulus,** Sampson.

Shothole borer.—*Anogeissus latifolia.*

Distribution.—[Tharrawaddy, Burma.]

**Platypus secretus,** Sampson.

Shothole borer.—*Aesculus punduana, Odina Wodier.*

Distribution.—[Katha, Burma]; Buxa, Bengal; Tonkin.

**Platypus solidus,** Chapuis[67].

Shothole borer.—*Acrocarpus fraxinifolius, Albizzia Lebbek, Anogeissus latifolia, Artocarpus elastica, A. integrifolia, Bombax malabaricum, Buchanania latifolia, Butea frondosa, Dalbergia Sissoo, Garuga pinnata, Hevea braziliensis*[68]*, Mangifera indica, Nauclea sessilifolia, Odina Wodier, Ptereosper-*

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[67] *Platypus solidus,* Chap. Strohmeyer in Coleopterorum Catalogus, pars 44, Platypodidæ, p. 17 (1912), lists *solidus,* Chap. and *pilifrons,* Chap. as separate species; in Genera Insectorum, Platypodidæ (1914), he omits *pilifrons* altogether. Winn Sampson in Ann. Mag. Nat. Hist., (9) IV (1919), p. 106, separately records *solidus* and *pilifrons* from Penang. There is, however, no doubt at all that *pilifrons* is the female of *solidus* and the name should be finally relegated to synonomy. I have taken both sexes together in pairs in their galleries and have bred long series of both in the same brood.

[68] Green, E. E., Trans. 3rd. Int. Congr. Trop. Agr., 1916, "Some Animal Pests of the Hevea Rubber Tree," p. 629.

*mum acerifolium, Schleichera trijuga, Semecarpus heterophylla, Shorea robusta, Sterculia villosa, Stereospermum chelonoides, Tectona grandis, Terminalia belerica, Tetrameles nudiflora.*

Distribution.—[Java; Sumatra; Ceylon]; Dehra Dun, Saharanpur, C. Almora (3,300′), Gorakhpur, Gonda, U. P.; Buxa, Jalpaiguri, Kalimpong, Bengal; Porahat, Pusa, Bihar and Orissa; S. Chanda, C. P.; Khandesh, N. Kanara, Bombay; S. Malabar, Madras.

**Platypus suffodiens,** Sampson.

Shothole borer.—*Adina cordifolia, Nauclea sessilifolia, Pithecolobium Saman.*

Distribution.—[Tharrawaddy, Burma.]

**Platypus uncinatus,** Blandford.

Shothole borer.—*Buchanania latifolia, Heritiera Fomes, Shorea robusta, Terminalia tomentosa.*

Distribution—[Ceylon; Belgaum]; Gorakhpur, U. P.; Jalpaiguri, Buxa, Sunderbans, Bengal.

## EXPERIMENTS IN SOWING SEEDS OF *CASSIA AURICULATA* (TELUGU—TANGEDU, TAMIL—AVARAM) AT GOLLA, ANANTAPUR.

As *Cassia auriculata* yields the most valuable tanning bark in India an account of the experiment carried out at Golla to determine the cheapest successful method of raising the shrub by sowing is of interest. The experiment has been conducted under the supervision of a Special Duty Ranger and a careful record has been maintained.

Six different methods of sowing, each on an area of not less than 5 acres, have been tried. These are—

1. Broad-cast sowing with no wounding of the soil.

II. Sowing in furrows about $2\frac{1}{2}'$ apart and $4''$ to $6''$ deep. The furrow is first made by ploughing, then seed is sown in it and the furrow is closed by another being ploughed alongside it.

III. Broad-cast sowing followed by close ploughing in one direction.

IV. Broad-cast sowing followed by close ploughing first in one direction and then at right angles.

V. Close ploughing in one direction followed by hoeing with a three pronged fork (or Goru) at right angles, then seeds sown in the furrows made by the prongs of the Goru, which are about $6''$ apart, and finally the whole gone over by a "Guntakah" or iron plate drawn by four bulls in the same direction as the original ploughing was done to root out grass, wound the soil, and cover the seeds.

VI. Dibbling seeds under trees in soil wounded to a depth of about $6''$ by a spike or crow-bar.

*Method I* has been carried out in Plot 12 of 6 acres. The sowing was done on 12th October 1919, when the soil was moist. There were 7 cms. of rain on 13th October and 40 cms. on 17th October, then no rain till 5th November. Fifteen seers of seeds were used. The seeds did not germinate and there are now no seedlings. No cost was incurred as the sowing was done by subordinates.

*Method II* has been carried out in Plot 1 (5·3 acres), Plot 2 (7 acres), Plot 9 (6 acres) and Plot 24 (5 acres). Plots 1 and 2 were ploughed and sown on 11th September 1919 and Plot 9 on 13th September 1919 during the burst of the North-East Monsoon. Plot 24 was sown on 19th November 1919 after 1·70 inches of rain on 11th, 14th, 15th and 17th November. The quantity of seed used in the above 4 plots was 52 seers, 73 seers, 62 seers, and 40 seers respectively. In plots 1, 2 and 9 germination began on the 5th day after sowing. There was rain at intervals for about a month after sowing and moisture in the soil for some 45 days after sowing. In the case of Plot 24 there was no rain after sowing till

January and there was no germination till then. A few seeds germinated as a result of 50 cms. of rain on 3rd January, but the tiny seedlings all died owing to continued drought afterwards. The cost of sowing and ploughing by this method comes to 14 annas per acre. A sample plot of ⅛ acre in Plot 2 showed 6,590 seedlings in January 1920, 6,473 in February, 5,686 in March, 2,179 in April, 1,007 in May, 592 in June and no casualties since. Seedlings are mostly 2" high and some may die next hot weather.

*Method III* was done in Plot 11 (5·5 acres) and on about 2 acres of Plot 15. In Plot 11 the sowing and ploughing was done on 22nd September after the burst of the North-East Monsoon and with some rain after sowing. In Plot 15 the sowing and ploughing was done on 19th November after 1·70 inches of rain, but with no rain afterwards till a little in January 1920. 108 seers of seeds were used for Plot 11 and 50 seers for Plot 15. In Plot 11 seeds began to germinate on the sixth day after sowing. In Plot 15 there was no germination till January when a few seedlings appeared as a result of a little rain. These were said to have all died owing to prolonged drought afterwards. I, however, noticed a very few seedlings which are probably due to germination of dormant seeds quite recently. The cost of the method is Re. 1-11-0 per acre. A sample plot of ⅛ acre in Plot 11 showed 18,818 seedlings in January 1920, 18,423 in March, 17,969 in April, 17,185 in May, 16,040 in June and since then no casualties. Seedlings are now mostly 4" to 5" high, have more leaves than those by Method II and may be called established.

*Method IV* was carried out in Plot 23 (5 acres). Ploughing and sowing were done on 25th and 26th September 1919 and 136 seers of seed were sown. Germination began on the 5th day after sowing. The cost works out at Rs. 3-9-6 per acre. A sample plot of ⅛ acre showed 12,727 seedlings in January 1920, 12,445 in March, 12,175 in April, 11,842 in May, 11,519 in June and no casualties since. Seedlings are now exactly in the same stage as those by Method III.

*Method V* was carried out in Plot 10 (5 acres). The ploughing, etc., and sowing were done on 21st and 22nd September 1919, and

104 seers of seeds were used. Germination started on the sixth day after sowing. The cost is Rs. 4-2-0 per acre. Enumeration on a sample plot of $\frac{1}{8}$ acre showed 27,167 seedlings in January 1920, 27,050 in March, 26,775 in April, 26,486 in May, 26,394 in June and no casualties since. The seedlings are larger and stronger than by any other method, now 8″ high on an average.

*Method VI* was carried out in Plot 13 (5·6 acres) in patches under trees, bushes and prickly-pear on 8th October 1919, when the soil was moist. There was a little rain on 13th and 17th October and 1·82 inches of rain in November. Germination began on the sixth day after sowing. The cost comes to Re. 1-6-0 per acre. Enumeration of seedlings in four patches showed 3,314 in January 1920, 3,133 in February, 1,710 in March, 311 in April, 75 in May, 10 in June and 7 in July. These few remaining seedlings look miserable and will probably not survive. No weeding or tending of any sort was done in any of the plots after sowing.

We have obtained very valuable results :—

(*a*) That the cheapest successful method is II, that it costs 14 annas per acre, and that by it sufficient seedlings are obtained to stock any area about 4,800 per acre.

(*b*) That by Method III at double the cost we obtain about 27 times as many seedlings as by Method II, and that they are somewhat better grown at the end of a year.

(*c*) That Method IV is no better than III and costs Rs. 3-9-0 per acre against Re. 1-11-0 per acre.

(*d*) That by Method V about twice as many seedlings are got as by Methods III and IV, that the seedlings are better grown at the end of a year than by those methods and that the cost is Rs. 2-7-0 per acre more than in the case of Method III and 8 annas 6 pies more than in the case of Method IV.

(*e*) That Tangedu sowings under bushes fail.

(*f*) That late sowings fail.

I should like one more experiment to be tried, *i.e.*, the same as Method II, only the furrows should be 10′ instead of $2\frac{1}{2}$′ apart.

I think by it sufficient regeneration could be obtained and the cost should be considerably less than by Method II.

I give my predecessor Mr. A. B. Jackson's description of Golla Reserve: "It is situated about 25 miles from Anantapur on the road to Kalyandrug—it is 6,760 acres in extent. The ground is undulating and the soil gravelly and very stony, the whole surface being covered with stones about the size of one's fist. The greater part of it was probably at one time cultivated but the soil is very poor and in this dry district the success of crops on such land must be extremely problematical. There is a scattered growth of Acacias (*Sundra, planifrons, Latronum* and *leucophlœa*), *Randia* and a few *Cassia auriculata* and *Fistula*. It is just the kind of place in which Tangedu should be grown, *i.e.*, land which it is possible to plough but which is too poor to yield profitable field crops."

H. C. BENNETT,
*I. F. S.*

## CO-OPERATIVE SOCIETIES IN FOREST VILLAGES.

The benefits resulting from the system of co-operation are so convincing and far-reaching that the rapid expansion of the department of the Co-operative Societies will be advocated by all right thinking citizens of the country. The department not only preaches the co-operative principle but affords material and practical aid among others in Industrial and Agricultural matters.

As a good many working plans, in Bengal at any rate, are based on clear felling and artificial regeneration (Taungya), the establishment of an adequate number of forest villages on suitable lines is indispensable and this has been found to be no easy matter in some divisions in Bengal. It is up to the Forest Department now to see that the forest villagers are not left behind by their confrères—the ordinary villagers outside the reserved forests. The Department of the Co-operative Societies is establishing societies among these outside villagers all over the country, rescuing the villagers from the clutches of the land-

owners and money-lenders and raising them to a state of independence and prosperity. Forest villagers coming under the administration of the Forest Department have not come within the scope of the Co-operative Department as a matter of course, and unless the Forest Department rise to the occasion by taking early and very special interest in introducing the co-operative system amongst their villagers, these will not only dwindle but be very difficult to keep satisfied and in a flourishing condition.

The forest villagers of some divisions are given advances by the Forest Department to enable them to get a start on their first crops and these advances are recovered by work done. This system keeps them out of the hands of extortioners but has the disadvantage of letting the department in, as sufficient security against the advances can hardly be expected nor is the loan turned to full account. The co-operative system would mean a mutual fund where mutual interests would be centred and with the departmental control of the banks the chances of abuses of loans could be brought to a minimum.

The introduction and working of the system would have to be entrusted to the Co-operative Department which deals with such matters exclusively. The supervision and auditing by the Co-operative Department would ensure the strict observance of rules. In the matter of supplying credits to the rural societies the following method is at present adopted by the department:—

The Bengal Federation (which approximates a Provincial Bank) with its headquarters at Calcutta, receives loan on about 4 to 5 per cent. from private individuals who are eager for safe investments, and loans out to the Central Co-operative Banks for say 7 per cent. A central Co-operative Bank loans out to its affiliated Rural Societies on say 10 per cent. and the Rural Societies loan out to their members on 15 per cent. The margin of difference between the rates of borrowing and lending is quite sufficient to meet the working expenses at the different stages of the system—the Federation, the Central Bank and the Rural Credit Societies. The working expenses of supervision are less than those in other analogous organizations of credit, *e.g.*, a Joint

Stock Bank, inasmuch as the spontaneous and unpaid co-operation of the workers is the first essential in the starting of societies, specially of the Rural Societies. At the same time a fairly important place has to be assigned to '*bad debts*' and loss accruing therefrom. It is, therefore, made compulsory by the Co-operative Department in the sanctioned bye-laws of the affiliated Rural Societies that 25 per cent. of the net profits of each society at the end of each year must be set aside for a Reserve Fund. As a matter of fact such stress is laid on a Reserve Fund for ensuring a good foundation for the society, that, for the first few years of the life of a Rural Society, no dividends are actually declared but almost all surplus profits, never less than 50 to 60 per cent. of the profits, are put aside in the Reserve. The Reserve Fund is a very sure index of the actual condition of the society and when that fund grows to a substantial amount, much good work such as the encouragement of education in the locality, the improvement of sanitation and means of communication, the erection of a decent building for its office, etc., could be effected.

The attraction of local credit from among the members themselves for the use of the needy members of a Rural Society and also the compulsory deposit by members in the funds of the society at suitable intervals—monthly or fortnightly—are invaluable in making a healthy atmosphere of self-help and thrift. The ideal of each society should be to become as self-contained as possible and with mutual trust and eagerness to help fellow members, a society could not only save members from the clutches of the money-lenders but could effect improvements in the locality in various ways.

The above deals mainly with Credit Societies, which of course is the first requirement of the impoverished forest villagers. Equally important however would be the functions of the Supply and Sale Societies and the Industrial Societies working in the areas of the Rural Forest Credit Societies. The Sale Department of the Supply and Sale Societies would help to dispose of the products of the members of several Rural Societies in the locality

and thus dispense with the middle-men, whose profits would now be shared among the producers themselves. The Supply Department of the Supply and Sale Societies would be able to provide all the necessaries of the members of different Rural Societies at lower prices than those offered by the local markets and this Department could also supply the seeds necessary for the forest villagers at the discretion of the Agricultural and Forest Departments. The Industrial Societies would help to encourage such cottage industries as weaving, oil-mills, etc. The Weaving Societies would be the most important of these as the cotton available from the forest Taungyas could be conveniently spun into yarn or cloth by the women and children during their spare time. This would supply almost all the cloth necessary for a family in the year as also for selling to the public and an immense saving would thereby result.

The forest villagers being all found rent-free, the system would prove more beneficial to them than to the outside villagers. Such a result would be most useful.

The system has been introduced, it is said, by the Sericultural Department in Bengal with very good results.

The writer does not pretend to experience and knowledge other than such as can be gained in the position he has held. This note is intended for open criticism and expression of views which should prove both interesting and useful.

DOW HILL: S. K. MUKERJI, F.R.,
*October* 1920. *Instructor, Kurseong Forest School.*

[This scheme is being tried in Bengal. Comments from the Central Provinces, Burma and other provinces having forest villages will be welcome.—HON. ED.]

VOLUME XLVII NUMBER 2

# INDIAN FORESTER

*FEBRUARY, 1921.*

## THE NEW FOREST RESEARCH INSTITUTE AT DEHRA DUN.

We think it timely to place before our readers some account of the expansion of the present Research Institute and of the shape which this expansion is taking since the preliminary arrangements for the new organization are now well in hand.

The causes which led up to the proposal and the proposal itself are dealt with in Despatch No. 495 of 12th December 1919, from the Government of India to the Secretary of State. The following extracts from the despatch are of interest :—

"We have the honour to invite a reference to our Finance Department telegram of the 29th July last, in which we foreshadowed the submission of a comprehensive scheme for the expansion of the Forest Research Institute at Dehra Dun. The existing Institute was established in accordance with the sanction conveyed in Lord Morley's Revenue Despatch No. 61, dated March 23rd, 1906; its scope was extended in 1911 and in 1915. Results of practical value are of necessity slow of attainment in dealing with forest crops; nevertheless a substantial foundation has been laid and creditable results have been obtained both in the scientific and applied branches.

"We have long recognized the limitations of the Institute and been convinced of the necessity for expansion, and we have been strengthened in this conviction by the report of the Industrial Commission, which lays *special stress on the necessity for its development* in order to meet the rapidly increasing demands of the country. In paragraph 63 of that report the equipment of the Institute is described as wholly insufficient and the necessity for increasing the number of research officers is pointed out. The requirements of forest education are also hampered by the limited accommodation at present available and extension in this direction is also necessary.

"It has not been possible, during the war, to provide the necessary laboratory equipment and staff, but in view of the rapid developments that have recently taken place in the utilization of the forest resources of the Indian Empire—all tending towards rendering the country less dependent upon foreign sources of supply—and the unique opportunities, which now present themselves, of developing forest industries and of finding uses for hitherto little known products, we consider it of special importance that action should be taken without further loss of time to make provision for present and future requirements. Large commercial and industrial interests are involved; the State forests cover 251,512 square miles, the net revenue has risen from Rs. 74 lakhs in 1892-93 to Rs. 150 lakhs in 1912-13 and to Rs. 210 lakhs in 1917-18, and we consider that these increases, large as they are, are capable of very great expansion. Our expenditure on research and education during 1917-18 amounted to less than one per cent. of the surplus. This appears to us to be wholly inadequate; the greater part of our forest properties are undeveloped and we have no hesitation, therefore, in putting forward proposals which will permit of the functions of the Institute being more correctly proportioned to the importance of the issues at stake.

"We have considered the possibility of decentralizing forest research and have consulted local Governments in this matter. In connection with the Function Committee's report the necessity for maintaining research institutes under the Central Government has been accepted, and though local Governments, generally, have

urged the acceptance of the principle that in matters of special and local interest they should be free to provide for and carry out research, there is unanimity of opinion as to the necessity for a central institution to deal with the more strictly scientific portion of research, for the general guidance and co-ordination of investigation, and for the collation and distribution of information and the publication of results. We are completely in agreement with this view, which is in the interest of rapid development and follows, we understand, the practice in the United States.

* * * * *

"It will be seen that we do not propose to increase the number of the existing main divisions of the present Research Institute comprising Sylvicultural, Botanical, Zoological, Economic and Chemical branches, but that each will be sub-divided into a number of sections manned by experts under the general control of the head of each branch.

"*Sylvicultural branch.*—The present staff is composed of a Sylviculturist (Imperial) and two Indian assistants. Although research into sylviculture will also be carried on in some provinces we consider that the importance of this branch for research and statistical purposes should be strengthened by the addition of two assistants (Imperial). We are impressed with the necessity for improving our sylvicultural knowledge and for applying it, through working plans, to more modern and concentrated methods of treatment. We propose to retain the two posts of Indian assistants, one in the upper and the other in the lower class.

"*Botanical branch.*—The existing staff consists of a Forest Botanist and two Indian assistants. We propose to divide this branch into three sections dealing with Systematic Botany, Œcology and Mycology, each under an officer of Imperial status. The first two of these posts will be filled by forest officers, but it will probably be necessary to go outside the Department to obtain the services of a Mycologist. The existing posts held by Indian assistants (upper grade) will be retained and a third post of assistant (lower grade) will be added so that each section may be provided with an Indian assistant.

"*Zoological branch.*—This is staffed at present by a Forest Zoologist and two Indian assistants, one in the upper and one in the lower grade. Our knowledge of forest insect pests is still elementary, but it is sufficient to indicate that they are an important factor to be reckoned with in all stages of forest management and utilization and may even determine the degree of intensity or concentration of treatment and exploitation. We therefore consider that our zoological branch should be fully equipped to deal with the main problems of forest zoology and we propose to employ a Forest Zoologist and four regional zoologists, *i.e.*, officers who, though attached to the Institute, will conduct researches in different parts of India. It may not be immediately possible to obtain forest officers to fill these five posts, but it is essential that officers employed on this work should have good knowledge of forestry and we therefore intend that the posts should ultimately be filled by recruits to the Imperial Service who have undergone a special course on the conclusion of the period of ordinary training. As, however, some years will have elapsed before it is possible to fill the posts in the above manner we consider it desirable to employ, at once and as a temporary measure, a Systematist, to be located at Dehra Dun, and thus to enable the existing Zoologist to devote more time to touring and field work than is at present possible. It is intended that one of the four posts of regional Zoologist shall not be filled while the Systematist is employed. Each superior officer will have the services of an Indian assistant.

"*Economic branch.*—This important branch is at present in charge of a Forest Economist aided by an Assistant Economist, both of whom are Imperial officers. As the development of our resources, and consequently of our revenues, is mainly dependent, at any rate immediately, on the activities of this branch we attach special importance to its expansion. We propose to retain the two officers already employed placing the Economist at the head of the branch, and to add permanently a Wood Technologist and Minor Produce Expert, both to be ordinarily recruited from the Imperial staff. We have, however, at present no officer with the requisite

knowledge and training to undertake the duties of the former post, and though we hold that it should be filled permanently by a Forest Officer we must, as this class of investigation is of pressing urgency, employ a trained expert temporarily until it is possible to provide a Forest Officer with the necessary training. Our cellulose expert is only a part-time adviser. The importance of developing the paper-pulp resources of the Empire justifies the retention of his whole-time services for a period of five years, which, as at present advised, we consider will be a sufficiently long period to enable him to do all the investigation required. Similarly we consider that five years should be sufficiently long for the retention of a tannin expert. In this post we propose to employ Mr. Pilgrim, who is already in our temporary employment. The power plant and machinery will necessitate the employment of an engineer mechanic and an expert wood worker.

" *Chemical branch.*—We desire more definitely to divide the work of this branch according to the main lines on which investigations are to proceed, and we therefore propose to place the Forest Chemist in general charge of the branch and to add biological and distillation chemists. Each officer will require the help of an Indian assistant. This branch can conveniently be recruited from the proposed chemical service if constituted.

" The above proposal involves an increase in the number of Imperial Forest Service officers employed at the Institute from 6 to 11, and eventually perhaps 15, if it is found possible to obtain officers with the required training to undertake the duties of the regional zoologists. The Mycologist, the three Chemists, the pulp and tan experts (temporary) will not be forest officers.

" Our proposals necessarily allow for the provision of adequate laboratory and workshop equipment. In your telegram of the 4th September 1919, you have sanctioned the deputation of Mr. Raitt, our cellulose expert, to England with a view to obtaining special plant for investigation of the problem of utilizing the enormous quantities of grass, bamboos and other materials available for the manufacture of paper-pulp. In our telegram of the 9th September 1919, we also asked your sanction to the deputation

of Mr. R. S. Pearson, Forest Economist, in interruption of his leave, to procure laboratory and workshop equipment from America and England. We estimate the total cost of our requirements for the above equipment, including the necessary buildings, at Rs. 4,00,000, and whatever your decision may be on our proposals regarding the large scheme of expansion, the plant is urgently necessary for research that is possible under existing conditions : we have therefore made a grant of Rs. 3,00,000, to be utilized during the current financial year for this purpose.

" In connection with the necessity for expansion and the best means to be adopted to give effect to it, it has been brought to our notice, and emphasized by the Board of Forestry at its triennial meeting in March last, that the existing site is inadequate for immediate requirements and will allow only of inadequate expansion in future. The existing estate covers 47·8 acres and provides accommodation for the main research building, laboratories, small workshops, three residences, a hostel and a playing field for students. It would be possible to acquire an area of 29·7 acres adjacent to the present site, but there is no possibility of further extension in this locality. Difficulty is already experienced in housing the existing staff, as Dehra Dun is a rapidly growing town and an important cantonment in which house accommodation is below requirements. We have therefore been forced to consider the provision of house accommodation as part of the scheme of expansion. We are also faced with the necessity of providing accommodation for the increasing number of Provincial Service students. But even if it were possible to erect the buildings now required for research and residential purposes on an area of 77·5 acres and also to improve a water-supply which it is stated would be insufficient for the increased staff and work connected with it, we should still have no room for future expansion and no provision could be made for those experimental and demonstration areas which we consider of special importance in connection with an Institute depending so largely on field work for its results, both in education and research. The transfer of the Research Institute to a more central locality was discussed by

the last Board of Forestry and has received our consideration but no better centre can be found. Dehra Dun offers certain climatic and other advantages for educational, research and practical work both in the plains and the hills, while we consider it advisable to continue the traditions already established there as the main centre of our scientific and educational activities in forest work. We have accordingly decided to retain the Research Institute at Dehra Dun and have, after very careful consideration, selected a site of about 1,300 acres, at a distance of four miles from the town, with a view to providing, in addition to the requirements of the main buildings, workshops and residences, ample space for the necessary field work and for the future expansion of staff and equipment which we feel certain will take place. The cost of acquisition of the land for the new site is estimated at Rs. 4,80,000.

" While 1,000 acres would be sufficient for this scheme, we propose to take the opportunity of simultaneously acquiring a further area of 200 acres for the following reasons. It is highly probable that the Chemical Service Committee, the appointment of which was sanctioned in your Despatch No. 86 (Revenue), dated 25th July 1919, will recommend the creation of one or more research institutes. The Industrial Commission in paragraph 121 of their report definitely contemplated the probability of a Central Research Institute being located at Dehra Dun where the presence of the Forest Research Institute will tend to attract other institutions for research work, thus creating a scientific centre with an atmosphere favourable to research. We consider that the rapid appreciation of land value at Dehra Dun fully justifies us in making immediate provisional arrangements for acquiring the necessary site.

" The total outlay on the acquisition of a new site, the erection of the necessary buildings and the provision of workshop and laboratory equipment is estimated at approximately Rs. 30,58,000 distributed as follows :—

| | Rs. |
|---|---|
| 1. Acquisition of 1,200 acres of land at Rs. 400 per acre .. ... ... | 4,80,000 |

| | | Rs. |
|---|---|---|
| 2. | Plant, equipment and buildings for laboratories and workshops ... ... | 4,00,000 |
| 3. | Erection of new Forest Research Institute main building ... ... ... | 10,00,000 |
| 4. | Quarters for 60 Provincial Forest Service students (30 to be taken annually for a two years' course) ... ... ... | 1,50,000 |
| 5. | Residences for 22 Imperial officers at an average cost of Rs. 19,000 each ... | 4,18,000 |
| 6. | Residences for 16 Provincial Forest Service officers at an average cost of Rs. 10,000 each | 1,60,000 |
| 7. | Clerks' quarters ... ... ... | 1,00,000 |
| 8. | Menials' quarters ... ... ... | 50,000 |
| 9. | Field assistants' quarters 10 at Rs. 5,000 each | 50,000 |
| 10. | Roads, water-supply, laying out and contingencies ... ... ... | 2,50,000 |
| | Total ... | 30,58,000 |

"This sum represents only about one-seventh of the net revenue of the Indian forests for the year 1917-18. We do not consider the amount by any means excessive, and believe that it will be money well spent in expediting the development of our vast forest resources."

This big scheme was sanctioned in a telegram from the Secretary of State on 25th February 1920. Since then possession has been taken of the land which is very well situated from two to four miles west of Dehra and to the north of the Chakrata road. A special Works Division has been formed under the Public Works Department, Delhi Province, to deal with the project and possibly with others of a similar nature which are in the air, and the Department is fortunate in that the executive engineer is the officer under whose direction the present Research Institute was erected and who is therefore fully conversant with our needs.

The main building will be the centre of the site plan around which will be set some of the buildings for officers under training,

the economic and other workshops and laboratories, the demonstration areas (chiefly for growing forest crops), the parks with collections of trees and playing fields, the bungalows and subordinates' and menials' quarters. The ground slopes gently and evenly from north to south and is bounded on the north-west by the high bank of the little Tons river, an admirable situation for bungalows in the somewhat airless Dun. The greater part of the area has a good loam soil and one of the irrigation canals of the Dun passes diagonally across it. The main building which is in the hands of a special architect will accommodate the administrative offices, research offices and laboratories with some exceptions and the instructional portion of the rooms necessary for officers under training. The building will be planned to allow for expansion of the various branches, and is expected to take the form of three sides of a square. It is hoped to make the educational branch self-contained with its own preparation and model rooms and students' laboratories.

Both the Economist and Zoologist have been recently on leave, the former being also on deputation, and as this scheme was under consideration before they left India they spent a good part of their time in studying up-to-date methods in their separate branches in England and America. In particular Mr. Pearson made a rapid tour in parts of the U. S. A. and Canada, spending some days in the U. S. A. and Canadian laboratories at Madison and Montreal, engaging the services of experts and purchasing machinery of different kinds. As a result there should be built a series of thoroughly modern buildings with equipment which moreover will be capable of extension and adaptation to future requirements.

The Workshops and Laboratories of the *Economic Section* will be divided into two groups, one containing shops chiefly dependent on steam, the other on electric power. The latter block of buildings is to consist of a Minor Forest Products Laboratory, suitably equipped ; a Timber Testing Workshop, fitted with one ten thousand, one thirty thousand and one hundred thousand pound Universal Testing Machine, two Impact Machines, a Dogspike

Pull Machine, an Expansion-Contraction Machine and a Warp Testing Machine; a Wood Workshop, with saws, lathes, surfacing machines, etc.; a veneer or three-ply laboratory, fitted with a 36" veneer cutter, presses, etc.; and an Iron Workshop, to carry out running repairs. Adjoining these workshops are the offices of the various sectional officers. The laboratories and workshops, which are dependent on steam power, will form the first group and will consist of a hall to take the Tan extract plant; another for the Pulp and Paper section, fitted with a fractional digester plant and 36" paper making machine; a section composed of four *Sturtevant Drying Kilns and a battery of three Tiemann Steam*-Spray Kilns; and lastly a hall in which will be located an absolutely up-to-date experimental pressure creosoting plant. This block of buildings also has a building close by it to accommodate the controlling and clerical staffs.

Eight 100 ft. godowns, connected with the laboratories by tramline, have also been provided, and to complete the outfit a saw-mill has been purchased to supply timber to the various sections. The only section not accommodated in these buildings is that of the Wood Technologist, who will be housed in the Main Institute. The above-mentioned experimental machinery has been purchased, some of it being already in Dehra and the rest on its way out to India. The question of obtaining the services of men capable of running the various units has been taken in hand, Mr. Sweet, late Chief of Timber Seasoning at Madison, U. S. A., and Major Seaman, head of the Timber Testing, McGill Forest Laboratories, have been appointed. Mr. Raitt is at home getting his pulp plant prepared and Mr. Pilgrim, the Tan expert, is already in this country. The posts of Wood Preservation Officer and Wood Technologist have also been sanctioned and will probably be filled shortly.

One effect of the Economist's visit to America was a greater appreciation of the necessity of timber research in all its sections, and of the great benefits which have resulted from its steady application to American industry.

This is the only branch of the new Institute in which up to the present the terms of Despatch 495 are considered insufficient;

on the other hand it is thought that with the necessity for local sylvicultural research and the increasing amount which is being done in the provinces the sylvicultural branch can be reduced to one Imperial officer with assistants.

The staff which it is now considered should be entertained at the Institute, other than that for the educational branch, is as follows :—

| Branch. | Section. | Assistants attached to sections. | Remarks. |
|---|---|---|---|
| Sylvicultural | ... | 1 Upper grade Assistant | There will be an officer in charge of each branch and of each section. Most of the Upper grade Assistants will be paid Rs. 250—20—750 and a duty allowance of Rs. 75 thus ranking with Extra Assistant Conservators. Lower grade Assistants will draw Rs. 60—200 and a duty allowance of Rs. 50 and they will thus rank with Rangers. |
| | | 1 Lower grade do. | |
| Botanical ... | Systematic ... | 1 Upper grade do. | |
| | Œcological ... | 1 Do. do. | |
| | Mycological ... | 1 Lower grade do. | |
| Zoological... | Systematic ... | 2 Upper grade do. | |
| | 4 Regional ... | 3 Lower grade do. | |
| Chemical ... | Biological ... | 3 Upper grade do. | |
| | Distillation ... | | |
| Enconomic, | Wood Technology... | 1 Assistant. of the status of an Imperial Officer. | |
| | Seasoning ... | 1 Assistant do<br>1 Upper grade Assistant | |
| | Timber Testing ... | 1 Assistant of the status of an Imperial Officer.<br>1 Upper grade Assistant<br>1 Lower grade do. | |
| | Wood preservation | 1 Upper grade do. | |
| | Minor Forest products | 1 Do. do. | |
| | Paper-pulp ... | 1 Do. do. | |
| | Tans ... | 1 Do. do. | |
| | Mechanical Engineering. | 1 Asst. Electrical Engineer. | |
| | Wood working ... | 1 Veneers Upper grade Assistant.<br>1 Saw-mill do. do.<br>1 Wood Workshop Superintendent. | |

We may conclude by quoting some extracts from the recent decennial celebrations at Madison which disclose some of the results to industry which are to be expected from well developed research in the economic branch. Results of equal but perhaps more gradual and less obvious importance—certainly more difficult of assessment—are obtained in the other branches.

" Mr. Winslow, Director of the Laboratory, gave statistics showing by conservative estimate that the work of the Forest Products Laboratory effected an annual increase in production and decrease in waste aggregating $30,000,000. These figures, the speaker said, should prove the value and importance of industrial research.

* * * *

" Director Winslow at another meeting spoke of the expansion of the work of the laboratory during the war. Prior to 1917 it had a personnel of eighty and in eighteen months expanded to 500 and at present there are something less than 250 engaged in the work. The aggregate expenditures in the ten years were in the neighbourhood of $2,000,000, or a yearly average of $200,000 which is an insignificant sum when the breadth of the field and the magnitude of the problems are considered.

* * * *

" Some of the results of the work that may be expressed in dollars were presented. Investigation at the laboratory on the mechanical properties of American woods made possible a 20 per cent. increase in allowable working stresses and structural timbers, which made possible a saving of $40,000,000 annually, and if results are actually applied to only 10 per cent. of the material used the annual saving will equal $4,000,000.

* * * *

" In shipping containers, proper methods of mailing developed and recommended by the laboratory and adopted by the National *Association of Box Manufactures and others*, if conservatively estimated to save but 1 per cent. of the $100,000,000 of loss paid by the railroads each year, would mean a saving of $1,000,000 to the people.

* * * *

"Work of waterproof glues and plywood during the war saved the war department $6,000,000 in one year.

* * * *

"Investigations during the past year in the way of hull fibre and second cut cotton linters made available 200,000 tons of material for this purpose and resulted in the erection of large plants with a production of 300 tons per day and an annual sales value of $15,000,000. Improved methods in turpentining resulted in increased yields and less injury to trees, with a net saving aggregating $4,000,000 annually. These few examples show a combined annual increase in production and decrease in waste of $30,000,000, which will show the value and importance of industrial research as carried on by the Forest Products Laboratory."

* * * *

We shall report the progress of the Institute to our readers periodically and hope to gain and keep the sympathy of the members of the Department, both of those who have visited Dehra Dun and of the many who have not, for the task which is before us.

Those who can look back a generation on Indian Forestry can realize very clearly by how much the scope of the life work of an average forest officer has been widened by recent developments which have originated from research work, whether purely scientific or utilitarian.

We are merely at the beginning of this expansion. The Central Institute will look for the help of all members of the Department and we trust that the Provincial Governments will afford the aid in men and materials which may be required, from time to time, to create and maintain the vitality of the new Institute. Large numbers of Indian visitors outside the Department come to see our museums at the present.

We should be glad to welcome more visitors to the Institute from our own Service.

## THE USE OF AIRCRAFT IN FORESTRY AND LOGGING.

[The Canadian Forestry Magazine for October contains an interesting article on the use of aircraft in forestry and logging by Mr. Ellwood Wilson, Chief Forester of the Laurentide Coy., Ltd, Grand Mère, Quebec. In view of the interest which has already been displayed in this journal in the use of aircraft for forest work we reproduce the article in full, but regret we are unable to reproduce the illustrations. Mr. Ellwood Wilson was a delegate from Canada to the British Forestry Conference held in London during July and his exposition of the advantages of aircraft for certain kinds of work, illustrated by excellent photographs, created a strong impression on the members of that Conference. His paper presents results achieved and gives suggestions which are based on intimate personal knowledge of the subject. The Department has among its officers or probationers several who were employed in the air force during the war so that it would not be difficult to organize a branch to carry out observations in certain localities, such as the delta regions of Burma, in order to determine the utility of aircraft for forest work in India.

Mr. Ellwood Wilson also read a paper on this subject at the 11th Pacific Logging Congress which met at Vancouver, B. C., from the 6th to the 9th October. A full account appears in the "Timberman" for that month.—HON. ED.]

The writer has been in charge of the Laurentide Company's aerial work for two seasons and gives herewith the results of the work. The first season showed absolutely the practicability of the planes for reconnaissance of unmapped or mapped areas, for transportation of passengers and of fire-fighting equipment, for looking over the work of log drives, for spotting forest fires and for aerial photography.

The winter was spent in overhauling planes and engines and in the study of the pictures, taken from the air, on the ground. This spring a photographic laboratory was equipped so that photographs could be handled well and expeditiously. The work commenced on the 17th of May and has been continued regularly to date, the appended table giving the amount of work done :—

| | |
|---|---|
| Miles flown ... ... | 6,006 |
| Hours flown ... ... | 101 |
| Photos taken ... ... | 3,000 |
| Acres photographed ... ... | 543,100 |
| Fires spotted ... ... | 34 |
| Passengers carried ... ... | 23 |

### Staking a Mining Claim.

The longest flight from the base was 250 miles out. In the course of the work done above, many things of different sorts were accomplished. A flight of forty-four miles was made to stake out a mining claim. The plane carried four people, two tents, folding canoe, provisions and instruments. The party stayed out two nights and much time was saved, as, in the ordinary course of events, it would have taken two days to travel each way by canoe, and with the plane it took less than an hour.

A boundary survey of some limits had to be made and the starting point was difficult to locate, as, if all the work were to be done on the ground, 22 miles of chaining through the woods would be necessary to locate an intersection from which to commence. The plane was sent up and the three sides of the triangle necessary to locate the intersection were photographed in one day and the course the new line would have to follow was also photographed showing all the lakes, streams and hills which the line would cross.

On two sides of the triangle, where lines already existed, they were visible in the photographs at numerous places on the ground and could easily be joined up. Thus all of the field work is practically checked up before beginning the work, which can now be planned with great exactness. It is proposed to put provisions on the lakes which the line will cross ahead of the party so that they will only have to carry enough to last for a short time and save heavy portaging through the woods.

### A Quick Job in Mapping.

Explorers were taken over territory which was offered for sale, and of which there were no maps. The observer sketched in the burns, timbered areas and other information, at the same time got a very good idea of the country as a whole. Then taking his sketch map he went in on the ground and estimated the timbered areas, saving much time which would have been wasted in locating the burnt areas. In one trip a reconnaissance of about four hundred square miles was made. The Logging Manager

made several trips of this kind and with his sketch maps and his bird's-eye view of the country was able to lay out and direct the work of his explorers. Several flights were made to note the progress of drives and it was very easy to see just how the work was progressing and whether the streams were being swept clean or not. In one case a large number of roll-ways of logs were discovered and photographed which had been left in the woods the previous season. Trips were also made to look over and estimate the number of logs in the sorting booms so that the time and number of men required to saw, so as to finish the winter, could be determined. The Logging Manager and his Superintendents were taken to and from distant points of their work and much valuable time saved.

AN AIR INVENTORY.

One of the most valuable parts of the work was photographing lands which are to be purchased for planting. A complete dictionary of these lands was made, and as the photo gives every detail it is of great value. Lot lines, buildings, fences, ditches, roads all show plainly and the areas of different kind of land also.

Even the character of the soil can be seen. The areas in cleared land, swamp, burn, scrub timber, and good timber can be easily measured with a planimeter and the exact value of the land determined. A scale of prices for the different kinds and qualities of land is determined and all lands are bought by it. The seller and the purchaser can sit down over an aerial photo and make a trade much better than in any other way, for they have all the details before them.

In planning all kinds of engineering work, laying out roads, ditches for drainage, areas to be planted and so forth, the photos are of the greatest assistance, and by taking a series the progress of the work can be checked very much more rapidly than by ground measurements. The areas cut over in a logging operation can be checked on the photos, the roads can be seen, areas left uncut can be determined and the general efficiency of the work can be judged.

### What the Work Costs.

The general results from the work promise well and the Laurentide Company has decided to make aerial work part of its operations. Permanent hangars are being built, together with houses for the personnel and shops for the care of repair work.

The cost of the work, as carried on experimentally, has not been excessive and as it becomes standardized, can be materially reduced. The main thing is to have the machine in the air as much as possible so as to cut down the unit costs of the work. The cost per mile works out at about $3 per mile and the cost of photographs at about 2·6 cents per acre. This is based on the use of the HS2L seaplanes which use about 25 gallons of gas per hour and are slow climbers. Also there are many items of expense which are incident to beginning the work and which will be eliminated later when more experience has been gained.

### Easy Transportation.

To sum up the results so far obtained, for carrying men, whose time is valuable, to distant parts of the work, the planes are most useful. The manager of a company, with large woods interests gets tied down to his office and mill work, and a trip into the wood consumes so much time that he does not like it. The same is becoming increasingly true of logging managers and superintendents. They do not like the hardships of long journeys into the woods and being out of touch with their general work for days at a time. With the planes, the most distant operations can be visited and the work inspected with only one night away from home. Local foremen in the woods will be kept up to their work much better. In case of accident doctors can be readily taken into the woods and injured men brought out. Mail can be taken in and reports brought out much oftener.

For rapid reconnaissance the planes are invaluable. Tracts which are for sale can be inspected in days where weeks were required and the information obtained is much more accurate and fuller than can be had from ground work. In a few hours in the air, the general drainage of the country can be determined, burns,

swamps and timbered areas sketched in, the species present noted and the general character and quality of the timber ascertained. Windfalls and insect damage can be seen and all areas estimated with more accuracy than from a strip survey. When the ocular survey is supplemented with photos, there is no room for doubt about the character of the country and instead of depending on the opinion of the man who has made the reconnaissance, all the responsible men interested can get together and discuss a purchase or a proposed operation intelligently and with the information before them.

### SPOTTING FIRES.

Spotting forest fires and taking help to extinguish them is a valuable part of the work.

The carrying of provisions to distant operations will certainly become a part of the work before long, doing away with the building of expensive tote roads and making possible the placing of provisions just before the work begins, instead of taking them in the previous winter, thus doing away with spoilage and the cost of insurance and the labour necessary to watch them. Then, too, it will not be necessary to build large depôts from which, often times, quite long hauls to separate camps must be made, but provisions and gear can be put right down at each camp.

In the purchase of lands for other than logging purposes, aerial photos are invaluable, giving as they do, *all* the information required.

### ARE AERIAL PHOTOS RELIABLE ?

The aerial camera is going to be more and more indispensable. So far as our studies have gone, the types of timber and land can be accurately determined. The actual number of trees in the crown cover can be determined and a fair idea of the general size of the stand obtained. For forest maps they are infinitely better than ground surveys, giving all the information needed rapidly and accurately and in a form which everyone can easily learn to understand. Instead of the information being

stored up in a man's head or in his notes which are often coloured by his personal idiosyncrasy, it is always available and leaves no room for varying opinions.

The technic of reading these pictures and of making estimates from them is being carefully and thoroughly studied and a regular dictionary being built up. Much ground work will be carried out this winter, especially in the estimation of quantities, from the photos.

### THE SEAPLANE IS BEST TYPE.

The following general conclusions can be drawn from the experience gained thus far. For work in country where there are many lakes, the seaplane is the best type of machine. The float type has not proved satisfactory, as the floats are very fragile and easily become water-logged. The seaplane is structurally strong and rugged and will stand much harder usage. It presents a fairly stable platform for a camera. The type we are using is ideal from every point of view except cost of operation and we have purchased a Curtiss "Sea Gull" for patrol work, passenger carrying and photography.

The larger machines will be used for carrying provisions, large parties and fire-fighting apparatus.

### CHOOSE PILOT WITH CARE.

The personnel of a flying station is a matter of great importance. Experienced pilots are necessary, and the fact that men have wide experience in flying land machines does not always qualify them for seaplane work. Only the highest type of men should be employed, both as pilots, mechanics and riggers, as men of a lower type are likely to have a lower sense of the responsibility and importance of their work. Men who are reckless or who drink should never be employed.

Rigid inspections before flights are absolutely essential and no machine should ever go up if there is the slightest doubt about it being in perfect flying condition. The amounts invested are large and the loss of a machine is a serious matter, even leaving out of account the risk to the personnel.

## USES OF THE DIRIGIBLE.

The development of the "Pony Blimp," or small dirigible, opens up a new line of development which is very promising. With a speed of 45 miles per hour and a wide cruising radius, it uses only three gallons of gas per hour and has a greater carrying capacity than a plane. As it can be stopped in the air at almost any altitude, it offers an ideal means of timber cruising and mapping and for carrying fire fighters and equipment and also supplies for survey parties and logging camps. If the risk of fire is not great and the cost of plant for charging with gas not too expensive it will be an ideal adjunct to forestry and logging work. It will also do away with, what in the north-eastern part of the continent is a great drawback to aerial work, the inability to fly in winter. It may be that we shall be able to make flying practical but so far it is out of the question with planes on account of the low temperatures and deep snows which we have in eastern Canada.

I feel that aerial transportation and photography have come to stay and that with careful, well thought-out development will prove invaluable in the management and exploitation of large timber holdings. We are constantly trying to study out new ideas for the planes and the camera and are sure that their field of usefulness will become larger and more important.

## HOPLOCERAMBYX AND THE DYING-OFF OF SAL.

BY C. F. C. BEESON, M.A., I.F.S., FOREST ZOOLOGIST.

For the last five years sal trees have been dying-off in abnormally large numbers in Thano Reserve, Dehra Dun Division, U. P., an almost pure sal forest occupying some 4,800 acres on a terrace or *chaor* at the foot of the outer Himalayas. The dying-off was first reported in 1916; since that year the forest has been under observation by the Forest Research Institute, mainly by the Forest Zoologist on the assumption that the mortality was due to a severe borer epidemic. The progress of the epidemic has enabled us to revise our ideas of the œcology of the borer

(*Hoplocerambyx spinicornis*, Newm.), and incidentally suggests some explanations of the sporadic dying-off of sal in various parts of its habitat. A brief account of the conditions in Thano may therefore be of general interest.

The following statement shows the numbers of trees marked annually as borer-attacked trees, classed in two groups according to the appearance of the tree at the time of marking, *viz* :—

GREEN = living trees with green foliage, dammar-flow or small quantities of ejected wood-dust.

DRY = dying or recently killed trees with the foliage dry or fallen, and with abundant amounts of ejected wood-dust.

The penultimate column shows the total annual rainfall of the nearest meteorological station, Dehra Dun.

| Year. | Green trees. | Dry trees | Total. | Annual rainfall. | |
|---|---|---|---|---|---|
| 1916-17 ... | Unclassified. | | 6,772 ... | 94·37 ... | 1916. |
| 1917-18 ... | 6,203 ... | 3,987 ... | 10,190 ... | 116·98 ... | 1917. |
| 1918-19 ... | 23,160 ... | 385 ... | 23,545 ... | 45·71 ... | 1918. |
| 1919-20 ... | No enumeration. | | ... | 66·24 ... | 1919 |
| 1920-21 ... | 2,991 ... | 610 ... | 3,601 ... | 70·25 ... | 1920. |

As they stand the figures are misleading, but with judicious interpretation they yield instructive data. It is not necessary here to go fully into the method of interpretation and the history of the markings and fellings; but it may be mentioned that, owing to the employment of different marking parties for the enumerations, the conception of what constituted a borer-attacked tree varied very much, so that the figures for '*green*' trees are open to criticism. If we plot the total numbers of '*dead*' trees marked each year (with the values for 1916 and 1919 estimated from sample plots) against the total annual rainfall, a striking parallelism of curves is obtained; if we plot the gross totals or any other

combination of values no enlightening graphs appear. The diagram in plate 3, opposite this page, shows the correlation between deaths and total annual rainfall.

It seems logical to conclude that *the annual rainfall is an important factor in the dying-off of sal and in the efficiency of the borer-attack in a* Hoplocerambyx *endemic area.* In years of abnormally high rains a higher proportion of trees is killed by the borer than in years of abnormally low rainfall in this forest. Moreover in the period under observation the annual rainfall has departed considerably from the mean, and at the same time the mean annual rainfall (normal) is rising.

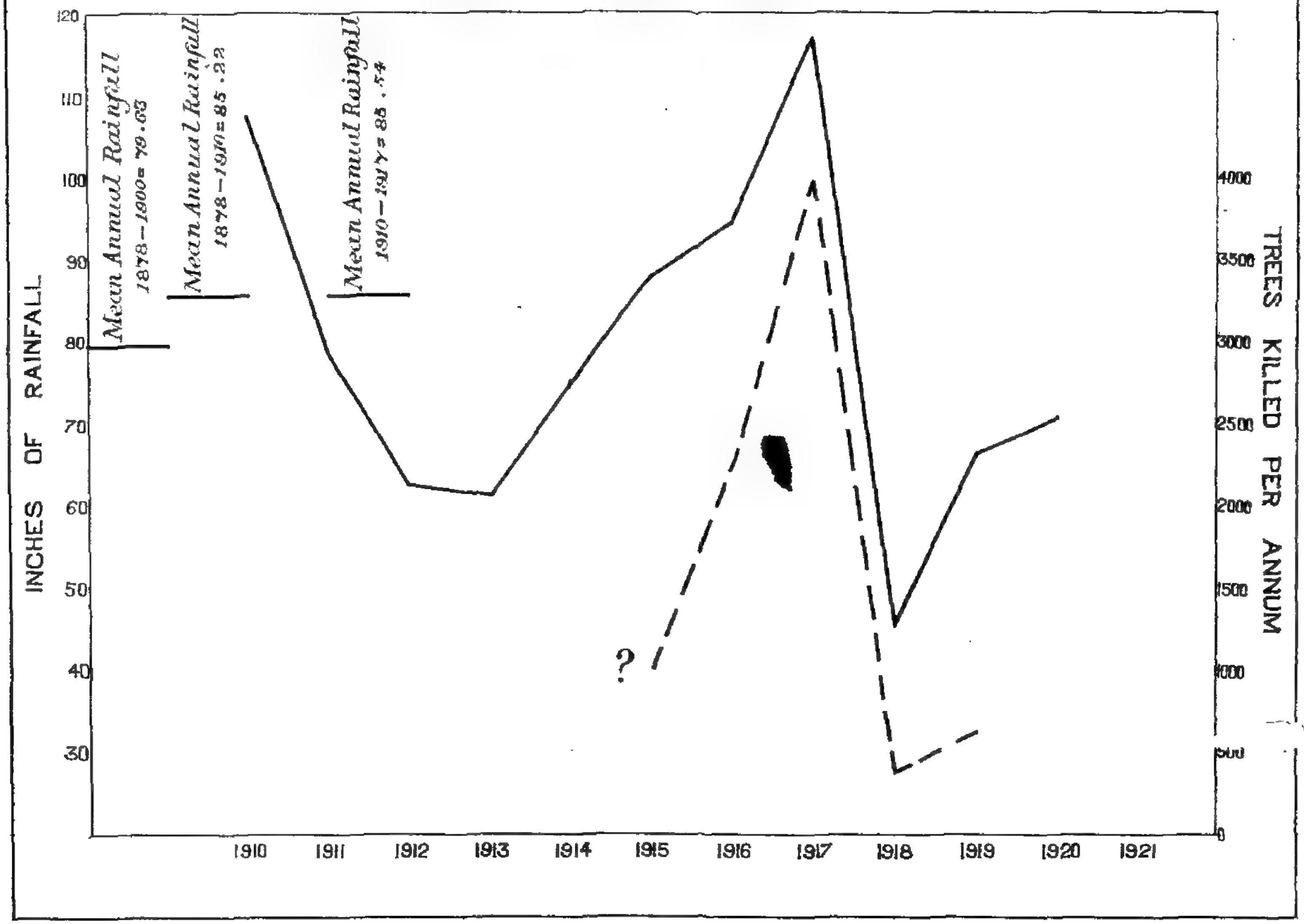
The effect of rainfall can be considered from two aspects, (*a*) the effect on the insect, and (*b*) the effect on the tree.

(*a*) It has previously been shown that the emergence period of the beetle is directly influenced by the initial date of the rains and their extent,* through their effect on the moisture-content of the heartwood of sal and the relative atmospheric humidity of the pupal chamber of the borer lying in the heartwood. In a wet year some 75 per cent. of the beetles emerge in the first month of the rains; in a dry year the period is prolonged to six or eight weeks. Assembling, pairing and oviposition are facilitated and the possibilities of mass-attack are increased; there are, moreover, indications that in seasons of deficient rainfall fecundity and longevity are decreased.

Applying these facts to the question of variations in the annual abundance of the borer in Thano forest, we should expect a gradually increasing incidence from 1912—1917, [*vide* rainfall curve]. Extensive dying-off of sal was not recognized by the divisional staff until 1916, but the records of the Forest Zoologist's office show that dying borer-infested sal trees were not uncommon as early as 1913 in those parts of the forest now most seriously affected; in 1911 and in 1912 they were not observed. Stebbing's records for previous years must be rejected as he was of the opinion that *Hoplocerambyx spinicornis* did not occur in the United

* Beeson, *Construction of Calcareous Opercula*, For. Bull. 38, 1919, p. 7.

CORRELATION OF RAINFALL AND TOTAL DEATHS OF SAL TREES IN THANO FOREST. U.P.

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Provinces at all.* The writer inclines to consider the northern part of Thano forest as an endemic focus of *Hoplocerambyx* at which it has increased as a result of favourable climatic conditions culminating in 1917.

(*b*) As Hole has shown,† the saturated soil of a sal forest in the rains develops an injurious factor that may cause the death of the surface roots of large trees, and he has pointed out that the death of the deepest feeding roots, particularly of the dominant and most vigorous trees, may be caused by a light rising of the water-table. In the loose boulder deposits on which Thano forest stands it is probable that the latter factor does not obtain although there appears to be evidence of local ponding-up of drainage in the tributary gullies of the main consequent ravines, that have extended their head-waters into the foot-hills. It is difficult to ascertain if the former type of injury, *i.e.*, surface water-logging, occurs. The areal distribution of the mortality has remained more or less in the same localities throughout the course of the epidemic; the most severely attacked compartments are those in the higher levels of the tract, and those containing the older age-classes and the highest proportions of sal in the crop. Of the 66 compartments comprising the epidemic area, 46 occur on a deep, rich, or clayey loam, and 21 compartments on a sandy or gravelly loam.

In 1917, the wettest year, 26 compartments were heavily attacked and in 1918, the driest year, 17 compartments were heavily attacked. The following table shows the distribution of the attack with reference to the soil factor in 1917 and 1918:—

| Year. | 46 compartments on clayey loam. | | 21 compartments on gravelly loam. | |
|---|---|---|---|---|
| | Heavy mortality. | Light mortality. | Heavy mortality. | Light mortality. |
| 1917 ... | % 26 ... | 74 ... | 70 ... | 30 |
| 1918 ... | % 20 ... | 80 ... | 38 ... | 62 |

* This error is repeated in *Indian Forest Insects*, 1914, p. 321; on p. 2. Stebbing unfortunately propounds a theory of the distribution of forest insects, based on the supposed absence of Hoplocerambyx from submontane sal forests.

† Hole, *Œcology of Sal*, i, Ind. For. Rec. V, iv, 1914, p. 39; 1916, p. 80.

| Year. | Number of compartments with heavy mortality. | Percentage occurrence on | |
|---|---|---|---|
| | | Clayey loam. | Gravelly loam. |
| 1917 ... | 26 ... | % 46 | 54 |
| 1918 ... | 17 ... | % 53 | 47 |

These figures show that in the wet year, 1917, the heaviest mortality occurred among trees growing on a sandy or gravelly loam, while in the dry year, 1918, the mortality decreased on sandy soils and increased relatively on clayey soils. Apparently none of the deaths in 1918 can be assigned to drought, due to rapid percolation on the drier sandy loams, on the contrary it is possible that the better drainage of such soils (assisted by the numerous gullies which are more developed in those areas than in the clayey loams) prevents the formation in normal years of the injurious factor due to bad soil-aeration.

The question of bad soil-aeration as a contributory cause in the development of the borer incidence may be considered in connection with the above figures. During the beetle emergence and oviposition period (*June 26th—end September, 98 days*) there were in 1917 84 rainy days as against 45 in 1918. Rainfall on the former scale is quite sufficient to produce the injurious effect of bad soil-aeration in a well-drained loam as Hole has shown for sal seedlings,* and as Marriott has suggested in the case of older trees.† A check of this nature during the growing season reduced the tree's power of resistance to borer attack, and allows a mass-attack by the insect to become fatal. Successful resistance to attack is marked by copious outpouring of resin or dammar, which floods the larvæ galleries and drowns the young larvæ. Such trees are not necessarily re-attacked in succeeding years; (sample plots show the proportion escaping re-attack was over 90 per cent. in the years 1918, 1919). That the resistance of the tree is influenced by the rainfall is shown by the ratio of trees

* Hole, *Œcology of Sal*, For. Rec. V, iv, 1914, pp. 18-20.

† Marriott, *Sal Forests of Gorakhpur*, Ind. For., xliii, 1917, p. 444.

killed outright to those surviving attack, *viz.*, in 1917 39 per cent. of the attacked trees were killed, while in 1918 only 2 per cent. were killed *in spite of the enormously increased incidence of the borer.*

A comparison of the proportion of trees attacked to trees killed, classified by girth classes, shows that the mortality in 1917 was nearly uniform throughout, with a very slight preponderance in the smaller girth classes; and that in 1918 the mortality was much greater (almost double) in the smaller girth classes *vide* table below :—

| Year. | Girth Class. | Number of trees attacked and surviving. | Number of trees attacked and killed. | Percentage of trees killed. |
|---|---|---|---|---|
| 1917 ... | over 6' | 241 | 130 | 35 |
| | 5'—6' | 624 | 331 | 35 |
| | 4'—5' | 1,207 | 783 | 40 |
| | 3'—4' | 1,547 | 1,143 | 42 |
| | 2'—3' | 1,527 | 957 | 39 |
| 1918 ... | over 6' | 431 | 4 | 0·9 |
| | 4½'—6' | 2,008 | 15 | 0·7 |
| | 3'—4½' | 6,949 | 72 | 1·0 |
| | 1½'—3' | 9,018 | 154 | 1·7 |

In the early stages of the 1920 attack (a year of rainfall slightly below the mean) about 1½ times as many trees in girth classes 1½'—4½' have been killed as in girth classes 4½'—over 6'.

These figures seem to corroborate the idea that owing to bad aeration of the surface soil in a wet year the resistance of all trees is about the same, while in years of average or low rainfall the larger trees are more resistant than the smaller trees. The rootlets of trees killed in 1920 have been examined microscopically but there is no evidence of diseased conditions to the extent expected.

Other explanations of the mortality of sal in Thano have been put forward. The report on Forest Administration in the United Provinces for 1916-17, p. 11, says :—

"A conference with the Research Institute authorities* came to the conclusion that the attack was due mainly to the fact that the affected trees were all over-mature and hide bound, and, in short, were in an unhealthy condition and should not have been left in the crop so long."

* The writer was not present at this conference.

The same publication for 1917-18, p. 10, says :—

"The trees...........are almost all commercially mature and their removal will benefit the crop... ........A great many over-mature trees had without doubt been retained in *the crop owing to faulty prescriptions in the working* plan aiming at too large an exploitable size for the locality........ ...The trees suffered badly in 1916 from attacks of defoliating caterpillars. Then in 1917, owing to the continuous rain and cloud there was little direct sunlight during the growing season. Transpiration was reduced and consequently the flow of sap checked. It is believed that these causes enabled the usual sporadic attacks to become general."

The underlying idea contained in the last four sentences closely approaches the theory put forward in this article, *viz.*, that *the resistance of the trees to borer attack was directly lowered by a series of years of abnormally high rainfall.* But the idea that the mortality was distributed principally among over-mature and commercially mature trees is not supported by the figures given above.

As the Thano borer attack has been dignified by a special investigation and has become an entity in official correspondence the perspective with which it is viewed is apt to be distorted. There is no doubt that the forest was heavily over-marked in 1918 and it is equally certain that the low yield of attacked trees obtained in 1920-21 (3,601, which figure includes the trees killed in 1919 also) is due to the revised methods of marking adopted. The year 1918-19, which appears in the divisional records as the year of heaviest outturn of "*Hoplocerambyx* trees" is, paradoxically, that in which least damage has been done by *Hoplocerambyx*. In the most heavily attacked compartments the mortality was only 0·5 to 1·5 trees per acre, *i.e.* 1 to 3 per cent. of the growing stock over three feet girth. This degree is not very far above the normal mortality of sal due to "natural causes,"—a degree that is rarely appreciated in large divisions. Glasson has found that the natural death-rate for sal in Buxa Division is slightly over 1 per cent. per annum, and he estimates the death-rate for trees attacked by *Polyporus shoreæ* at 1·4 per cent. per annum.* The mortality in the heavily infested parts of Thano in 1917 reached 16 per cent. of the growing stock.

* Hart, *Inspection Note on Goalpara, Buxa, Jalpaiguri, Kalimpong and Kurseong Divisions*, 1920, p. 14.

It is not unlikely that the causes operating in Thano occur in similar Bhabar and submontane sal regions, but other factors are by no means excluded. Thus, in the moist forests of Bengal, *Hoplocerambyx* is secondary to the attack of the root-fungus, *P. shoreæ*, and a large proportion of the trees may die off without the assistance of insect-attack.* Again, in Gorakhpur Division *Hoplocerambyx* is absent and is replaced by *Æolesthes holosericia* which is secondary to *P. shoreæ*.† Root-fungi may, moreover, be consequent on a diseased condition of the roots produced by bad soil-aeration or drought.‡ On the other hand the extensive mortality in the plains sal forests of the United Provinces, due to the drought of 1907-08 was not accompanied by severe borer epidemics.§ There is evidently scope for the detailed investigation of the dying-off of sal in various parts of its habitat by a combination of œcological botanists, mycologists, entomologists and soil-chemists.

What has been written above tends to confirm the theory advanced by Hole on various occasions that the dying-off of sal poles and trees is primarily due to factors connected with soil-aeration, and strengthens the belief already expressed by the writer ‖ that borers of the type of *Hoplocerambyx* are *essentially secondary factors, which, however, under epidemic conditions may determine the death or survival of a weakened tree.*

Finally, it is necessary to point out that most favourable conditions for the increase in numbers of *Hoplocerambyx* in Thano were provided by the felling and non-removal of attacked trees in 1917—1920 (contrary to the advice of the Forest Zoologist). The felled trees have failed to act as traps, as it was hoped, and had the monsoon not failed in 1918 it is probable that the attack

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* Beeson, *Life History of Diapus furtivus*, Ind. For. Rec, VI, i, 1917, p. 3.

† Beeson, *Forest Insect Conditions in Gorakhpur*, Ind. For., 1919, p. 12.

‡ Hole, *Recent Investigations in Soil Aeration*, Agric. Jour. Ind., XIII, 1918, p. 438.

§ Troup, *The Drought of 1907 and 1908 in the Sal Forests of the U. P.*, For. Bull. 22, 1913, p. 15.

‖ Beeson, *Forest Insect Conditions in India*, Agric. Jour. Ind, XIII, 1918 p. 122.

would have been far more serious at the present time. The control measures in the case of an epidemic of *Hoplocerambyx* (in the Siwaliks and probably in similar sal forests) are as follows:—

1. Enumeration of attacked trees at the close of the rains preferably in November.

2. Felling and removal from the forest of all parts of the tree down to 18" girth before 30th April of the following calendar year.

3. Removal of all parts of the tree down to 12" girth in years of exceptionally high rainfall.

4. Trees to be removed have the following characteristics:—

(*a*) Dead or dying trees with the foliage fallen or turning brown.

(*b*) Trees with green foliage and an abundant ejection of wood-dust.

5. Trees to be left in the forest have the following characteristics:—

(*a*) Trees with green foliage and appreciable outflow of resin or dammer.

(*b*) Trees with green foliage and small amounts (*e.g.*, a handful) of ejected wood-dust.

Owing to the difficulty of drawing a sharp line, for practical purposes, between slightly attacked trees, 5 *a*, *b*, and heavily attacked trees 4 *a*, *b*, and to other factors in the biology of the borer the operations should be repeated in the following season. When a clearer conception of the natural death-rate of sal is obtained it will be possible to define a safety-limit in deaths per acre or per cent.

# THE ECONOMIC ASPECTS OF CINNAMON CULTIVATION IN SOUTH KANARA.

In the coast district of South Kanara Cinnamon (*Cinnamomum zeylanicum*) grows abundantly at elevations varying from 100 to 700 feet and fairly up to 3,500 feet on the Ghat slopes.

Regeneration from seeds is excellent and it coppices well.

It is a shade-bearer, but grows well in the open when once it is established. It thrives in any kind of soil except that in which sand predominates and can stand any amount of rainfall. In South Kanara the annual rainfall is about 140 inches. In scrub jungles Cinnamon forms a good percentage of the stocking. It is evergreen. Its leaves are not eaten by cattle but it is liable to injury by fire.

It flowers in January, the fruits ripen in May, and every few years it bears a heavy seed crop.

It is an important tree of commerce owing to the value of its bark, leaves and fruits. The local Government have recognized this; and in the district circular on the valuation of plots assigned on 'darkhast' the value of a seedling from the stage at which it sends forth its first pair of leaves to a girth of 6" is fixed at 4 as.; above 6" to 12" at Re. 1; from 13" to 18" at Rs. 2 and above 18" at Rs. 3.

The local distillers distinguish four kinds of trees from the taste of the leaves

(1) Mitta ... Sweet.
(2) Pickka ... Of insipid taste.
(3) Tej ... Pungent.
(4) Kadira ... Bitter.

They collect the leaves of only the last two for oil extraction; the first two are reported to be useless for this purpose.

According to Mr. W. E. Davidson (Ceylon Official Handbook, Paris Exhibition, 1900), the area under Cinnamon cultivation in Ceylon was 43,500 acres and the value of the export trade about 25 lakhs of rupees. Gamble tells us that at the time of the occupation of Ceylon by the Portuguese and the Dutch, the cultivation of Cinnamon was a Government monopoly; and the British Government also maintained the monopoly until 1833.

In India no extensive trade is reported; but now that a wave of industrial awakening is in evidence, it is the business of the Forest Department to find a market for the products of this important species, to study its propagation and growth and work it under a suitable sylvicultural system.

As this note is confined only to its economic aspects in the South Kanara district, I have been careful to note below only what is done in my range. In North Mangalore Forest Division of the South Kanara district, Cinnamon areas in the unreserved lands are divided into Cinnamon working circles; each one is intended to provide leaves for five stills annually during the working season from October to the end of April. The number of local distillers is fixed and each working circle is auctioned to a single individual.

As the growth is scattered over extensive areas and as only the two kinds of leaves already referred to are employed for oil extraction, men have to roam about for the collection of leaves. The existing system of working does not provide a rest period for any working circle. Each one is auctioned annually; and if the bid is sufficiently attractive, it is sold. Some working circles are not bid for at all during certain years as purchasers are afraid that they will not have sufficient yield of leaves for the season. These, therefore, get rest for a year or two when there is no good offer for them. On an average three stills are run in each working circle as leaves in sufficient quantities are not obtainable to run five stills simultaneously during the working season.

The average annual outturn in my range is about 25 tins of oil—1 tin = 24 bottles; and in the whole division reaches about a hundred tins. The price of Cinnamon oil varies locally from Re. 1-4 to Re. 1-8 per seer of 24 rupees weight in normal times; or Rs. 2-13-0 to Rs. 3-6-0 per bottle; one bottle = 2¼ seers; but last year it went so low as 8 to 10 as. per seer. The local 'sowcars' advance money to the distillers at 6 per cent. interest on condition that the latter would sell their stuff only to them at a fixed rate; and these men export it to Bombay which is the chief market for South Kanara oil.

On the extraction of Cinnamon oil as carried on in the South Kanara district an article has already appeared in the *Indian Forester*, page 88, Vol. XXXIV. From the leaves of the Cinnamon trees there is prepared in Ceylon, by maceration in sea water and subsequent distillation, a volatile oil (*Oleum cinnamomi foliorum*), Indian Pharmacopœia ; but in this district the first operation is not carried out.

The world war has terminated and now that the Government and the people are alike interested in the revival of all defunct industries a steady market for the bark, fruits and oil of this species is worth investigation.

The propagation of this species can be taken in hand without much difficulty as extensive areas in the Government unreserved forests which now contain only poor growth can be brought under Cinnamon by such simple operations as dibbling in seeds of 'kadira' and 'tej,' or broadcast sowing. I believe these operations should prove successful because I found the natural reproduction from seeds excellent in many of the 'darkhast' plots in unreserved lands which I valued. In two cases I counted about 3,000 seedlings and more than 200 trees above 6" in girth in one acre. Localities for sowing, to start with, should be banks of streams, valleys and shady places.

Cinnamon growth would thus be concentrated within small and compact areas ; and instead of seven working circles for the unreserved lands of 30 villages in a range, 30 working circles for 30 villages may be quite possible ; and instead of auctioning the same working circle annually the one sold during one year should be resold only after three years. A sustained yield of leaves for oil extraction, bark and fruits can thus be maintained ; and men would not have to roam afar as they now have to do in search of leaves.

Its medicinal use is now being recognized. I would quote in this connection a passage from a letter from the Sanitary Commissioner of Bengal to the Secretary to the Bengal Chamber of Commerce on the outbreak of influenza in Bengal.

"In this connection I may mention that the Sitaram Coal Company who used oil of Cinnamon in two drop doses amongst their staff of 282 men during the last epidemic (influenza) obtained very satisfactory results, as not a single case of disease occurred among those using this remedy."

I may also add that two drops of oil used in the initial stages and the dose repeated every two or three hours in case of cholera have been known to cure a number of cases in this taluk; and during the cholera season it might even be used as a preventive.

The medical opinion, I understand, is more in favour of the oil extracted from the bark; and the British and Indian Pharmacopœia give more importance to this (*Oleum cinnamomi*). Mr. Foulkes in his book on "Timber Trees in South Kanara" published in 1895 says: "The oil is still extracted from the bark in small quantities as required for medicinal purposes."

I enquired of the contractors in my range about the possibility of oil extraction from the bark; but they could give me no information. However a practical demonstration of this is necessary in the range, as there is a great demand for the oil from the medical practitioners and chemists as well as from the public. The following were the rates per ounce at which *Oleum cinnamomi* was sold in Madras in August last; and for this information I am indebted to one of the Madras dailies:—

| | | | Rs. | a. | p. | |
|---|---|---|---|---|---|---|
| Ranga & Co. | one variety | ... | 0 | 8 | 0 | per oz. |
| Ditto | another variety | ... | 1 | 0 | 0 | |
| Aswin & Co. | ... | ... | 0 | 8 | 0 | |
| R. McLure & Co. | ... | ... | 2 | 0 | 0 | |
| Ditto | another variety | ... | 6 | 0 | 0 | |
| Smith Stocking & Co. | ... | ... | 1 | 8 | 0 | |
| Dr. U. Rama Rao | ... | ... | 1 | 8 | 0 | |
| W. Smith & Co. | ... | ... | 7 | 8 | 0 | |

Ceylon, the Straits and Bombay are suppliers to Madras. Such a wide divergence in prices can be accounted for only in two ways; either owing to a number of varieties in this oil or to profiteering owing to the excessive demand for the oil in these times.

Now that the formation of Utilization circles is under contemplation and at least one province, *viz.*, the United Provinces has taken the lead, it is expected that others will also follow this example when I hope that this industry will claim the attention of experts in this presidency.

Of course the present paucity of establishment is an impediment ; but with a steady market for the products, the balance-sheet must certainly show a fine surplus even after making allowances for reasonable expenditure.

C. K. MENON, *Forest Ranger,*
*North Mangalore Division.*

# EXTRACTS AND REVIEWS.

## THE EFFECT OF FORESTS UPON STREAMFLOW.

Untersuchungen uber den Einfluss des Waldes auf den Stand der, Gewässer von Dr. Arnold Engler, Mitteilungen der Schweizerischen Zentralanstalt fur das forstliche Versuchswesen, Zurich, 1919.

Switzerland is a country of mountains with many villages nestling among them. Close watch must therefore be kept on the mountain torrents which often carry in their wake destruction of life and property. As in our own country, the general experience of the people who lived long in the woods and of foresters who observed the behaviour of streams rising in forested and unforested watersheds was that the forest has a beneficial influence upon the flow of water in mountain streams. The need for strict protection of the mountain forests was fully recognized and enacted in national legislation. There were, however, many timber owners who were bent upon clear or careless cuttings of the forests in the mountains because of the immediate higher profits from such handling of the timberlands. There were not a few engineers who sincerely believed that the influence of the forests upon the occurrence of floods and the flow of water in the streams was unduly exaggerated and were chafing under the restrictive forest laws. In order to settle the question of the Influence of the forest upon streamflow the Forest Experiment Station at Zurich in 1900 undertook accurate measurements on two small watersheds in the Commune of Sumiswalde, about 15 miles north-east of Berne. The Swiss Experiment Station, after 18 years of continuous observation, has just published its results as worked up to date. It is by far the most conclusive record which forest or engineering literature has so far produced. Its particular value lies in the analysis of the individual factors which affect the régime of mountain streams and therefore provides a scientific basis for determining for any given condition the

effect of forest vegetation or lack of it upon the behaviour of the stream.

Of the two Swiss watersheds selected for the experiment, one is known as Sperbelgraben. It comprises 137 acres and is wholly forested. The other is known as Rappengraben. Its area is 172 acres and is only about one-third forested. Sperbelgraben lies within the watershed of the Kurzeneigrabens and Rappengraben within the watershed of the Hornbach, both of which flow into the great Emme, and the experiment is known as the Emmental Experiment.

The comparison between the forested and poorly forested watersheds in Switzerland was begun at once.

The mountain range of Hinterarni, which in the peak Farnli reaches an elevation of 4,135 feet above sea-level, lies between the two Swiss watersheds. The distance between the two watersheds where they are nearest together is 2·4 kilometers in an air line. Both valleys trend north-east to south-west. The small tributaries which enter the main stream on the left have in Sperbelgraben a north to north-west exposure, on the right a south to south-east exposure.

With regard to exposure and geological structure, the two watersheds in Switzerland bear a close resemblance to each other.

The rock is the same in the two Swiss experiment stations and is only slightly permeable. No losses of water through its disappearance in deep-lying clefts were discovered.

The zero of the stream gauging apparatus in Sperbelgraben is 911·98 meters above sea-level. The streams are of practically the same length in both watersheds—3,617 and 3,851 feet, respectively, and the gradient is steeper on the forested than on the poorly forested watershed. The basin of Sperbelgraben is in the form of a long and narrow valley while Rappengraben is more in the nature of a deep kettle-shaped basin.

Complete meteorological observations were made at two control stations, one in each watershed, and the precipitation was measured at two addititional places in each basin, hence the precipitation depends upon measurements at three points in each

basin. Streamflow was automatically recorded at each of the two control stations, except during the cold season.

The mean temperature and the total precipitation by months is shown in the following table :—

MONTHLY MEAN TEMPERATURE F° SPERBELGRABEN 894 METERS.

| January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 7 | 29·7 | 34·3 | 40·8 | 49·5 | 55·2 | 57·9 | 57 9 | 51·6 | 44·9 | 35·4 | 32·2 | 43 2 |

MEAN PRECIPITATION (INCHES), SPERBELGRABEN.

| January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3·82 | 3·57 | 5 06 | 5·12 | 6 23 | 7 45 | 6 92 | 6 67 | 5·01 | 3·66 | 4·57 | 4·43 | 62·51 |

*Generally speaking the climate of the Swiss watersheds may* be classed as moderately cold and rainy. The temperature of the control station in Rappengraben is lower than that of Sperbelgraben. Precipitation is practically the same in both basins, if anything, it is greater on Rappengraben. Evaporation is probably greatest in Rappengraben on account of its free exposure to the sun and winds. Thawing weather occurs in winter in spite of the elevation. Föhn winds seldom occur, The snow does not accumulate.

The records of the discharge of the streams are available for the open season April 16 to November 30 of each year. It appears that the automatic water stage recorders at the Swiss station could not be made to function with temperatures below freezing. It would seem, therefore, that the published discharged values in per cent. of the precipitation are too high. Doubtless it was impracticable to make allowance for the ground-water in the watersheds at the beginning of the open season. This view is confirmed by computing the percentage of run-off for April. The

computed percentages from the data in Table 117 is—Sperbelgraben 103·2, Rappengraben 111·9. Occasionally the entries in this table for certain months greatly exceed 100 per cent. thus Sperbelgraben, April 1915, 258·4 per cent.; Rappengraben, April 1915, 205·7 per cent. This seems to show that a considerable part of the discharge as published was due to precipitation which had occurred in March prior to the beginning of streamflow records.

The disposition of the precipitation is as follows:—

| | Sperbelgraben per cent. of precipitation. | Rappengraben per cent. of precipitation. |
|---|---|---|
| Run-off ... ... | 59·3 | 61·9 |
| Evaporation (vegetation) ... | 14·5 | 11·8 |
| Evaporation (transpiration) ... | 18·9 | 8·1 |
| Evaporation (earth) ... | 7·3 | 18·2 |
| Total ... | 100·0 | 100·0 |

*In this connection the author remarks that since on the* basis of our investigations we have come to the conclusion that for mountain districts of like form, like topography and climate, the yearly run-off from the forested and non-forested areas in our rainy lower Alps is approximately equally great, therefore we may be permitted to assume that, expressed in round numbers, the proportionate amount of the yearly precipitation in forested and non-forested areas which constitute run-off and evaporation, respectively, are as follows:—

| | In Forest per cent. of precipitation. | In Open per cent. of precipitation. |
|---|---|---|
| Run-off ... ... | 60 | 60 |
| Evaporation (vegetation) ... | 15 | 10 |
| Evaporation (earth surface) ... | 5 | 24 |
| Transpiration ... ... | 20 | 6 |
| Total ... | 100 | 100 |

The results of the Emmental experiments are, of course, strictly applicable only to regions with similar climatic and soil conditions. The analysis, however, of the factors which determine the run-off on forested and open soils, as well as the manner in which the experiments were conducted, place the results on a general scientific basis. Many of the conclusions drawn by Dr. Engler may be regarded as generally applicable, while other deductions must not be generalized. There are so many factors working together in various ways which affect the regimen of a stream that it is essential to guard against careless application of the Swiss results to all cases. Careful consideration of the factors of climate and soil and their relation to the vegetation of forest and open land will, however, be the best safeguard against false conclusions.

One general fact that has been confirmed by the Emmental experiment is that a good forest cover has a very beneficial effect upon the régime of streams in mountainous and hilly regions. To be sure, it is not always possible for the forest cover to prevent floods. Under certain conditions, the forest soil may lose its retaining power entirely, as, for instance, during heavy general rains, so that as much water will run off from forest soil as from open land. But even in such cases the favourable effect of a soil under forest cover on the run off is still clearly noticeable. Thus while landslides occurred almost regularly in general rains on the steep meadow or pasture land or on bare land, the damage from this source on the forested watershed was very rare.

Another fact confirmed in the Emmental investigation was that streams fed from a forested watershed have a more uniform discharge and carry less débris into the larger rivers to which they flow than streams coming from an unforested watershed. The more numerous and greater high water stages in streams in an unforested region during heavy rains or rapid thaw increase erosion and carry the débris downward, where they are deposited on the alluvial cones or in the river channels and raise the river-bed. That the raising of the river-bed causes floods and damage to property is a well-established fact,

The Swiss experiments have conclusively shown that extensive damage from floods occurs less frequently in streams coming from forested watersheds than from the streams rising in poorly forested or treeless watersheds. There is, of course, no absolute guarantee against the power of the elements. We must be content with limiting and weakening their effects as much as possible.

The great importance of forests in hilly and mountainous regions in feeding springs has been proved beyond a doubt in the Swiss experiments.

While the total average annual discharge of the two streams measured remained about 60 per cent. of the precipitation over both watersheds for the entire period of observation, their behaviour after heavy rainfall of short duration, such as thunderstorms and cloudbursts, or after uniform heavy general rainfall or general rainfall of variable intensity or at the time when snow melted rapidly in spring or winter, was very different. Thus in the spring and winter with a sudden thawing of snow the highest water stage and the total amount of rainfall and run-off were considerably lower in the stream flowing from the forested watershed than in the stream from the lightly forested watershed. When the ground in the forested watershed was not frozen and was not saturated with water from previous rains, all the snow water was absorbed and the greater part of it was stored in the interstices of the soil on the forested watershed. No conditions occurred which enabled the Zurich Forest Experiment Station to determine how the stream in the forested watershed would behave were the rain to fall on solidly frozen ground as the ground in the forested watershed froze less than in the lightly forested, and when it did freeze the frost did not penetrate deep.

In heavy rainfall of short duration the retaining capacity of the soil in the forested watershed was remarkably great. The maximum amount of run-off per second in the forested watershed was only one-third to one-half as much as that in the stream in the lightly forested watershed for the same intensity and amount of rainfall. The total flow from the forested watershed

in heavy rainfall was usually only half as much as that from the lightly forested. If both watersheds had exactly the same configuration and if forest and shrub cover were entirely lacking in the lightly forested watershed, the difference of course would be still greater. The height of the water stages and the total run-off during the heavy rainfall of short duration, and this is true of all other rains, depended largely upon previous weather condition which held equally good for both watersheds.

In general heavy rains the retaining power of the forest and the soil varied greatly according to the previous weather or according to the water content of the soil and the duration of the rain. When the moisture content of the soil prior to rain was great, the forest cover proved ineffective and the run-off was the same as from the lightly forested watershed If, however, the soil was comparatively dry, the forest cover had a decided effect in reducing the amount of run-off.

In general rains of variable intensity the forest cover showed a tendency to retard the amount of run-off.

In the spring months when the snow melted and in the fall when the evaporation in the open was comparatively small, the run-off from the lightly forested Rappengraben was on an average greater than from the Sperbelgraben. In summer and winter, on the other hand, more water ran off from the forested Sperbelgraben than from the lightly forested Rappengraben. In the summer months, which in that region is the season of dry and variable weather, the stream in the forested watershed was fed more abundantly, more continuously, and more uniformly, than the stream from the open watershed.

The amount of run-off per second and per day fluctuated during each season much more in the stream from the lightly forested watershed than in the stream from the completely forested watershed. As a general rule, therefore, the forest cover had a controlling influence in stabilizing and evening out the flow of water in the stream.

This effect of forest cover in stabilizing and making the streamflow more uniform is due not directly to the forest cover,

but to the effect which it has upon the permeability and looseness of the soil and in maintaining a uniform temperature and moisture of the air and soil. The porosity and lightness of forest soil is brought about by the protection furnished by the tree crowns, by the formation of leaf mould, and by the presence of living and dead roots and an abundant soil fauna. The soil particles under forest cover are being continually moved and stirred up often to considerable depth. The species composing the forest, as well as the character of the stand, have a decided influence upon the degree to which forest soil is maintained in a porous and permeable condition.

Forest soil is very much more permeable to water than unprotected soil. Even on the steepest slopes forest soil absorbs the heaviest rainfall almost immediately. On protected forest soil rain-water flows off under the ground but on treeless soil, especially after heavy rain, or rapid thawing of snow, the water is discharged mostly on the surface. On steep sodded slopes the run-off was found to be the greatest. Water flows much more slowly *in* the ground than *on* it and a great part of the water does not usually run off at all but is stored in the interstices of the soil.

The whole explanation of the favourable effect of forest cover upon streamflow lies thus in the greater porosity and permeability of the forest soil.

The Emmental Experiment Station has discarded an opinion long held by many prominent investigators such as Ebermayer, Wollny, Ney, Henry, and others, that the great water retaining power of the forest soil is due mainly to the great retentive capacity of the leaf litter and moss cover. The experiments have conclusively shown that raw humus and moss cover have had a very unfavourable effect upon the water regimen. Many evidences of damage from floods in forested regions could be directly traced to accumulations of raw humus in the forest. It is true that raw humus and moss absorb large quantities of water but give off very little of it to the soil, and when once saturated they cause the rainfall to flow off on the surface. It was found that on a thick cover of pine needles and deep leaf litter, the rain-water ran off

very rapidly on slopes of any steepness. In a period of drought, on the other hand, raw humus and moss cover did not permit light rainfall to reach the ground at all. On the whole, raw humus and moss cover act upon the régime of streams like peat and moor soils.

The moisture content of the soil under forest cover and in the open follows different courses. In the open the soil, because of its greater compactness, contains a greater amount of capillary water than forest soil. The forest soil, on the other hand, contains much more ground water. The moisture content of the superficial layers of the unprotected soil varied more in the course of a year than in the protected soil. After prolonged drought the ground water in both forest soil and open soil may be the same but the moisture content of the superficial layers is greater in forest soil than in open soils. This is due to the fact that in forest soils the loss of water from the surface is being replaced by ground water, while in open soils no such reservoir exists.

The stream of the Rappengraben watershed carried more deposit than the stream from the forested watershed. This deposit came from landslides and from erosion in the gullies. No avalanches of sand or stone occurred during the time of observation in the forested watershed, while they did occur in the partially forested watershed.

Such in the brief are the deductions made on the basis of many years of careful measurement and observations of one forested and another unforested watershed.—[R. Z. in the *Journal of Forestry*, Vol. XVIII, No. 6.]

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# INDIAN FORESTER

*MARCH, 1921.*

## SIR GEORGE SANKEY HART, K.B.E., C.I.E., INSPECTOR-GENERAL OF FORESTS, 1913—1921.

With the retirement of Sir George Hart the Forest Department loses the services of one of a small band of eminent men who, as Inspectors-General of Forests in India, have devoted their lives to the best interests of the country and of the forest service. The association of such names as Brandis, Schlich, Ribbentrop, C. H. Hill, Eardley Wilmot, Beadon Bryant and Hart at once conjures up thoughts of constructive policy and personalities which the department as a whole can look upon with just pride. To write up their records would be to compile a complete history of the department from its very inception to the present time.

The relation of the Inspector-General of Forests to the Government of India is peculiar in that the position is a purely advisory one. Administrative control is exercised by the Inspector-General over the Forest Research Institute and College at Dehra Dun and over working plans in these provinces which have no Chief Conservator. It therefore follows that success in the position of Inspector-General of Forests is dependent upon the personality of the

individual as represented by administrative ability, initiative, energy and strength of character. With each of these qualities Hart is fully endowed but he also has an inherent sense of justice and fair play which pervades his dealings with individuals. During the eight years of his tenure of the Inspector-Generalship he has visited practically all the principal forest tracts of India. He has thus acquired a vast knowledge of the forests and of forest problems and perhaps the highest tribute that we can pay him is that he has everywhere established himself in the confidence of Government and of his department. His personality has won him the hearts of all with whom he has come in contact and every one who has once met Hart looks upon him as a personal friend.

*In the formulation of policy and the creation and consolida*tion of the forest estate much had been done during the first twenty-five years of our existence. During the next thirty years or so we had concentrated our energies in further rapid extensions of the forest area on the restoration of the ruined forests, in opening them up, and in the development of their resources. The staff had been steadily increased and although never adequate much had been accomplished. Hart thus came into authority at a time when the estate had been constituted and consolidated and in a measure restored. The time had come to realize the interest on our capital. To ensure the maintenance and, in many cases, the further accumulation of growing stock it became necessary to revise our working plans with a view to the gradual introduction of a normal succession of age classes. Our systems of silviculture have been altered to suit the then existing position, working plans have been recast on more advanced lines and in order to ensure the best results, the prescriptions have been made much more elastic than before. Our exploitation has in consequence been more concented and we are within sight of the introduction, wherever advantageous, of modern means of transport and conversion. The support accorded by him to the study abroad of modern methods of extraction and conversion must exercise great influence on our future work and revenues. Looking back therefore upon the past eight years we see marked advances in the development of our resources

and it must be admittted that, while the war created an exceptional demand for forest produce, in other directions much of our progress was delayed. In the three important directions of silviculture, working plans and exploitation, Hart has worked tirelessly to advance our knowledge and methods and we can trace in these and other directions Hart's guiding hand. His inspection notes, written in a clear and convincing style, have been of special value in the formulation of the policy of the provincial governments and of local officers.

Hart retires after nearly 34 years of service in India and he carries away with him the admiration of his department and their best wishes for long life and prosperity in his retirement.

## THE MANAGEMENT OF THE PUNJAB IRRIGATED PLANTATIONS AS SELF-CONTAINED FOREST ESTATES ON COMMERCIAL LINES.

The irrigated plantations of the Punjab differ in many important respects from any other form of forest plantation. The method of their establishment by means of irrigation is common to all of them; the species which can be grown in them are,—owing to the remarkable extremes of climate they have to contend with, namely, intense heat and cold, and intense drought punctuated with periods of irrigation,—limited in number. The resulting crops are very uniform in character, and the work of tending them is therefore a comparatively routine business. The ground being dead level, no difficulties in road or rail construction present themselves. In short these plantations are *sui generis* and their entire management can be effected much more simply and on more automatic lines than is the case in any other class of forest. Further, irrigated plantations must always be managed under the most intensive system of working. Thus in practice the rotation is between 15 and 20 years, during which period the entire area is worked over in three thinnings and a final felling. In other words their management involves more intensive working than is the case in almost any other class of forest either in Europe or India. Indeed, the work to be done per acre per annum approaches that

necessary in ordinary agricultural operations and is certainly directly comparable with that necessary to work a tea or rubber estate. It is therefore clear that the reduction of management charges to sizes analogous to those which experience has proved to be most convenient in such estates, is necessary.

2. *The value of the estates.*—The following list shows the approximate area available for irrigated plantations in the province :—

| Name of Forest. | Total area (acres). | Remarks. |
|---|---|---|
| Changa Manga ... | 12,523 | |
| Chichawatni ... | 11,103 | |
| Kot Lakhpat ... | 1,965 | Say 62,000 acres less 2,000 acres required for labour settlements, etc. |
| Tera ... | 408 | Total available for plantation 60,000 acres. |
| Khanewal ... | 19,000 | |
| Daphar ... | 7,000 | |
| Pir Mahal ... | 10,000 | |
| Total ... | 61,999 | |

The actual figures of revenue and expenditure for Changa Manga, the oldest plantation, for the past five years are as follows :—

| Year. | Total area planted (acres). | Gross revenue (rupees). | Gross * expenditure (rupees). | Surplus (rupees). | Net profit per acre. | Remarks |
|---|---|---|---|---|---|---|
| 1915-16 | 9,605 | 1,94,187 | 86,478 | 1,07,709 | 11-3-5* | Includes half D. F.O.'s pay. |
| 1916-17 | ... | 2,18,971 | 90,921 | 1,28,050 | 13-5-4 | |
| 1917-18 | ... | 2,66,129 | 91,245 | 1,74,884 | 18-3-4 | |
| 1918-19 | ... | 3,55,679 | 82,063 | 2,73,616 | 28-7-9 | |
| 1919-20 | ... | 4,37,423 | 2,55,474* | 1,81,949 | 18-15-1 | *Increase due to tramway construction. |

These figures, of course, include rent received for field cultivation before afforestation. This item will disappear, but on the other hand the quantity of forest produce will proportionately increase. Moreover it has already been demonstrated that owing to want of mechanical transport and an insufficient labour supply, an enormous

quantity of saleable material is not being made use of. In round figures, cut material to the value of between nine and ten lakhs of rupees is lying rotting in Changa Manga alone, owing to the lack of sufficient transport to remove it and to this must be added an unknown but very considerable quantity of material obtainable from thinnings prescribed but left undone owing to an insufficient labour supply. It is true that the placing of a much larger quantity of material on the market may tend to lower its price—a consummation devoutly to be wished—but even so, I consider that an average *net* profit of Rs. 40 per acre per annum may be taken as a conservative estimate for the future. Thus, the irrigated plantations of the province may be expected to yield a total net revenue of some rupees 24 lakhs per annum.

3. *Management on commercial lines desirable.*—We have therefore to deal with a property of very high value, which must be subjected to a system of very intensive management of a highly specialized character. The management of that property, unlike most other forest properties, has for its *sole* object the production of the largest possible quantity of timber and firewood. No grazing or other rights have to be met from it. In short it is a commercial proposition pure and simple, and in order to produce its maximum output at the lowest cost, must clearly be managed as a commercial undertaking.

4. *The staff necessary for working on a commercial basis.*—It has been demonstrated that most of the work is routine in character, and fundamentally distinct from other classes of forest work, and that a trained managing staff and labour force numerically comparable with that employed on a tea or rubber estate will be necessary. To obtain the best results this staff should be employed solely on this branch of forest work and should not be liable to transfer to forests of entirely different character. In short, this plantation staff should be regarded as a separate and specialized branch of the Forest Department. If this is done, it will be possible to concentrate its training on the work in hand instead of using ordinary rangers, foresters and guards whose training is designed to fit them for a number of conditions which never arise in the areas we are now considering.

To employ an officer who has spent two years at Dehra Dun at considerable cost to the State in acquiring knowledge which he will never be called upon to use, is obviously a mere waste of time and money. All the necessary training can be given in the plantations themselves by an officer of experience in the work, with the aid of a plantation manual embodying all the experience gained since the inception of these plantations, and which will now be compiled by a competent officer.

*Establishment required and conditions of service.*—All plantations will be under the control of a Director, who will be an officer of the Forest Department. He will co-ordinate sales, initiate experiments, control the postings and promotions of establishment.

He will be assisted by a Deputy Director who will also be an officer of the Forest Department who will act as his understudy and take charge when the Director is on leave. The whole establishment will be as exhibited in the table below :—

DIRECTOR
with an
Assistant Director
in charge
of all plantations in the province with a Central Office.

Plantation (corresponding to a Forest Division about 10,000 acres, 1 Manager and 1 Assistant Manager). — Plantation. — Plantation. — &c.

Block. Overseer in charge of a block of 2,000 acres. — Block. — Block, &c.

Sub-Overseer.
Beldars.
Forest villagers.

5. *Conditions of service, recruitment and pay of staff.*—The executive staff will be appointed directly by the Chief Conservator. It will be non-pensionable, and any officer's services may be dispensed with at three months' notice on either side. Provision for a suitable Provident Fund may be made. Many of these appointments can be made from retired Indian Army officers.

The following establishment will be necessary for a plantation of 10,000 acres :—

| Grade. | No. eventually required. | Pay. | Remarks. |
|---|---|---|---|
| Manager ... | 1 | 75 per mensem* 100—10—200—20—400. | *During 2 years' probation. In addition to a bonus of ½ per cent. of net profits. |
| Assistant Manager ... | 1 | Do. do. | To be appointed later on as required. |
| Overseers ... | 5 | 40—5—100 | Selected men eligible for promotion to Manager. |
| Sub-Overseers (selected beldars). | 10 | 20—2—40 | Drawn from forest village labourers as a rule. |

6. *The Accounts Branch.*—The conditions of service for all clerks will be similar to the executive staff. The office work will be mainly accounts work. There will be one central office at Lahore in which all accounts will be compiled separately for each plantation. All revenue will be paid direct by Managers to treasuries and these officers will merely submit a cash-book, a monthly summary of receipts and issues of stores and stock.

The central office will compile all accounts and will draw up a separate balance-sheet and profit and loss account for each plantation, and this will be audited annually by a firm of chartered accountants by whom all books will be examined. All important store indents will be issued by the central office, under the signature of the Director.

The following clerical establishment will be necessary :—

*Central Office.*

One Chief Accountant on Rs. 200—10—400 per mensem.

Assistant Accountants, one for every two plantations on Rs. 50—5—100—10—200 per mensem.

Two correspondence clerks, number to be added to if required, on Rs. 50—5—100—10—200 per mensem.

Peons on Rs. 14—2—20 per mensem.

*Manager's Office.*

2 clerks on Rs. 50—5—100—10—200 per mensem.

1 peon on Rs. 14—2—20 per mensem.

7. *Mechanical traction and its staff.*—The days of animal traction are over. Bullocks are too slow and are not obtainable. Each plantation must be fully served by tramways. The position of the entire permanent-way necessary in each plantation must be indicated on the map at the very commencement of operations, due regard being paid to the existing canal system and the direction of the irrigation channels. A staff consisting of the following will be employed :—

| | |
|---|---|
| 1 Permanent-way Inspector<br>1 Loco-Foreman Mechanic<br>1 Driver for each engine | for each tramway. |

The general control of all the tramways will be exercised by a Forest Engineer.

8. *Labour.*—Labour will be derived from forest villages, one of which will be established in each Block. These will be recruited from Baurias or elsewhere and will be paid at the rates current for the different classes of work to be done. The village will include areas of land sufficient to provide each labourer with a small vegetable garden. All forest produce of domestic use and grazing for a limited number of cattle will be allowed free.

9. *Summary.*—Each plantation will thus become a self-contained forest estate, managed on purely commercial lines like any other privately owned estate. Judging by the results already obtained in Changa Manga there is every reason to suppose that the

revenue from these estates is capable of very large expansion, and it is believed that a scheme on the lines of that now proposed will further that expansion more effectively than is possible under the present involved methods now practised.

J. W. A. GRIEVE,
*Conservator of Forests,*
*Eastern Circle, Punjab.*

30*th December* 1920.

# WANTED: A FOREST SOVIET.

BY A. J. W. MILROY, I.F.S., ASSAM.

[*December 16th*, 1920.]

One effect of the world-wide shortage of timber has been to attract concession-hunters to the Province of Assam in competition for timber monopolies over the big areas of forest, which have hitherto been very little worked, and the question of how these forests and the operations therein should most profitably be managed and controlled is one that requires serious consideration. Theoretically there should be no difficulty about the matter, because each of the two Circles in the Province is provided with its Conservator complete but one may be permitted to doubt, without being in the least personal, whether from the practical point of view the wisdom and foresight of a Conservator is sufficient in all cases to deal to the best advantage with such large slices of public property. Sylvicultural considerations apart, individual Conservators hold individual views regarding the most satisfactory way of exploiting forest produce; some are all for Departmental Operations, wherever practicable, some for employing outside agencies, and of those who hold this latter view, some believe that the Forest Department is justified in getting all that it can out of the exploiting companies, but others think that we can most effectively advertise our wares by allowing big profits to be made by the pioneers.

Efficient management cannot be attained without a settled forest policy, which is just what we have not had, and of which we are not yet in sight. The fact that we have never had a whole-time "Assamese" as Conservator may be blamed for this to

some extent. I do not mean to infer that men coming in from other provinces with fresh ideas have autocratically insisted upon running their Circles according to pre-conceived notions, because the reverse is actually the truth : succeeding Conservators have been so appalled by the difference between this and other provinces that most of them have more or less complacently accepted the *status quo* as expounded by their D. F. Os. They have scarcely had any alternative. Elephants are necessary for touring in Assam, and though communications by rail and steamer have greatly improved of recent years, it still takes the elephants the same time to march from one place to another, so that several seasons must have elapsed before a Conservator can have gone over his forests and feel himself in a position to take up an attitude in opposition to his D. F. Os. except on purely theoretical grounds.

Assam was linked to Eastern Bengal at the time when the two Circles were first formed, and considerable discussion arose as to the justification for the retention of both Circles after the Partition of Bengal had been rescinded. Luckily, the D. F. Os. were not consulted, for most of them believed that one Conservator with three sets of elephants, strategically distributed, was all that was needed in those days of stagnation in forest business.

It is necessary for a Conservator to obtain a thorough grasp of local conditions such as peculiarities of climate, the vegetation, markets, means of transport, labour supply, staff, tradition, and the idiosyncrasies of the officers under him before he can embark upon anything very striking in the line of a change of policy, and so, what with leave, prospects of transfer, the approaching time for retirement and so on, it generally comes about that that wicked old soldier, the D. F. O., is able to keep up his end, and resist all innovations of which he disapproves. Such progress as has occurred has been brought about almost as much by external pressure on the part of would-be concessionaires as by any internal passion for reform.

It is to be assumed that the reliance which Conservators have to put upon the man on the spot is seldom misplaced, but the

personal equation obviously comes in more than it should, and that may mean that only one side of the picture is presented.

The case of the Conservator, who during most of the time he served in Assam fully believed that it was impossible to tour with tents, may be quoted as an instance, a perfectly harmless and unimportant instance, of how a Conservator's views can be coloured by information obtained from his officers. The first Division, in which this Conservator toured, possessed an unusually large tent, which was a full elephant load when dry, and was more than one elephant could carry, when wet, and the Conservator somehow or other got it into his head through the D. F. O., who disliked small tents, that the dews were so heavy during the cold season as to preclude the use of tents when touring with elephant transport, and that bashas (grass huts) must be built in advance along the line of march. The consequence was that other Divisional Officers were always sent for the Conservator's tour programme well ahead with instructions to erect bashas where there were no rest-houses.

It is clear that a Conservator might similarly obtain professionally harmful impressions, and perhaps some of us could give instances of this happening.

It is not to be supposed that any forest officer would willingly deceive his boss, but a D. F. O. with an infatuation can conduct the Conservator round his Division in such a way as to convince him of the correctness of the infatuation. Tours in most Divisions have to be arranged with great circumspection, if time is not to be wasted by the elephants having to make lengthy detours (carts, even where roads exist, can seldom be hired unless seized by the police), and it is impossible for the Conservator to place his finger on the map and say "Take me here" and "Take me there," in order that he may have some opportunity of judging for himself what sort of things his D. F. O. considers important and what unimportant. He can only arrive at this after several seasons, but in the meantime he may be called upon to make important decisions, and he *must* make these as advised by the man in charge of the Division.

Both Conservators and D. F. Os. are constantly changing, and it is consequently clear that our forests are not getting the benefit of a well-considered continuous policy : the D. F. Os. individually may be anything from men of perfect judgment (as happens to be the case at present) to old birds with jaundiced prejudices, or fledgelings with more enthusiasm than judgment, and though each of them does good work, it is along his own lines, and the good work of one man may not tack on properly to the good work of his predecessor.

Working plans would, of course, prevent sylvicultural tinkering with the forests, first in one direction and then in another, but we have very few working plans in Assam (and those we have chronically refuse to " work "), and we are not yet able to prepare plans for the evergreen forests, the correct scientific treatment of which still requires evolving.

Working plans, in any case, only lay down the sylvicultural, and not the business, policy that should be pursued. The retarding effect, which follows from a succession of exotic Conservators, is exaggerated by the wholly malignant system, which confines each D. F. O. in a closely-sealed water-tight compartment. D. F. Os. know nothing of what is going on in other Divisions and have no means of learning. We do not even meet each other. I was nine years in this small Province before I met a brother officer, two years my senior.

Lest it should be assumed from the title of this article that a policy of powdered glass for Conservators, the Lenins and Trotskys of our official life, is going to be propounded, I must hasten to explain that the term "Soviet" originally meant nothing more sinister, we are told, than "Committee" or "Local Parliament," and that it is here used in this innocent sense.

My point is that, as circumstances may compel Conservators to rely upon the individual judgment of officers serving under them, they should be given the opportunity of consulting the opinion of all upon each matter of importance, irrespective of what Division or Circle it relates to.

Etiquette quite rightly prevents a Conservator from referring matters pertaining to one Division to some other D. F. O. except in the most casual and off-hand manner, and no one would be prepared to criticize a brother officer's work behind his back, however willing he might be to debate upon it in open assembly. It is perfectly possible under the present arrangement for a Conservator, who had spent all his life in the hottest and driest parts of India, to be called upon to administer an ever-green Division in Upper Assam in conjunction with a D. F. O. of, say, two years' total service and they spent in Sal forests, without being able to consult old and tried officers, familiar with the Division in question.

It is always up to men to record their great thoughts on paper before leaving a Division, but those of us, who suffer from that comfortable malady known as "Assam Rot" (once mis-spelt "Rut" in the heading in a Calcutta newspaper), find that it is quite fatal to the germ *Cacoethes scribendi*, and it is by no means easy to work out the past histories of our Divisions from the records extant; in any case, personal contact and discussion is worth many tons of paper, for just as some men cannot be got to write, so others cannot be got to read.

Two instances of what can happen in the absence of any advisory body may be given.

In the first case a Conservator set his heart upon developing a certain Reserve, whether with, or without, the approbation of the man in charge of the Division I do not know, and managed to interest the Local Government in his scheme. Other officers in the province prophesied failure, some from knowledge of the locality and others on general business grounds.

The operations did fail completely, and the Local Government dropped, it was said, $1\frac{1}{4}$ lakhs over the concern, money that might just as well have been thrown into the Brahmaputra.

The Forest Department as a whole got the blame, and there has been no temptation since to provide us with funds for forest enterprises.

The second case is rather different.

A new Head of the Province was persuaded by those interested that the tea-box industry was handicapped by the high royalties charged by the Forest Department, and that relief was necessary in order to allow the timber traders to go farther afield for their supplies, the nearer forests having become exhausted. An order was issued, accordingly, that the royalty on box-timber was to be reduced by half in the Division to which I had just been appointed. I protested against any such lowering of the rates unless it was accompanied by measures for re-stocking the denuded forests, and pointed out that the logical outcome of such interference would be still further reduction after the next zone of forest had been worked out, followed eventually by the box-makers having to be subsidized to carry on their trade. The Conservator's protests were equally vain. Sure enough further agitation on the part of the box-makers was followed by orders that box-wood should be given free, and it was not till this had been done for some time that the absurdity of the proceedings became recognized, and the full rates were re-imposed, after nothing had been accomplished beyond helping the traders to skin a wider range of country at the expense of the general tax-payer. Nothing was done to improve the exhausted Reserves, and now there is a clamour that these should be disforested because they are exhausted.

That was not the end of the business, however, as an amusing side issue arose. The Division concerned was responsible for collecting the royalty on all forest produce brought through it from Manipur State, a moiety of the revenue being retained to defray expenses and the balance credited to the State.

I was deputed on foreign service to Manipur some years later, and while serving there happened to ask why the State had agreed to the reduction of royalty on box-timber from its forests.

This, however, was the first the State had heard of the matter, and having calculated how much of their revenue had been given away without their consent the State authority proceeded to demand that it should be made good.

It appears that refunds of this sort cannot be made without the sanction of the Government of India, and rather than go up for this the Local Administration had to recompense the State in some other way in order to get out of the mess.

Luckily for me, my procedure had been quite correct. I had circulated copies of the orders announcing the reduction of royalty on "all" box-timber, and when the R. O. charged with the collection of Manipur revenue wrote in and asked if the orders applied to State timber too, I had replied that they did, in my youthful belief in the omniscience of the powers-that-be.

Now, it is quite clear that no Conservator could embark upon an enterprise that appeared sound to him but perilous to the majority of his officers without incurring very great personal responsibility (from which no good man, sure of his ground, would ever shrink), and it is equally clear that no Local Government could over-rule the considered opinion of a number of its own officers in the way that the Conservator's opinion was over-ruled in the second case quoted without first weighing the arguments of both sides, and adequately considering what might be the effect of any action taken.

It is not suggested that an assembly with any controlling powers should be set up, but merely that all the Imperial and Provinical Officers in the Province should meet once annually to thresh out the problems of how the affairs of the owners of the forests, the tax-paying public, may most advantageously be conducted in accordance with their implied or expressed wishes.

Bureaucracy is deservedly a hideously unpopular form of government because it never takes the trouble to explain how it arrives at its determination to pursue a certain course, but simply proceeds on its way regardless of the fact that the exasperated owner of the whole caboodle may hold the opinion, rightly or wrongly, that his interests are not being adequately considered.

I once heard an Inspector-General of Forests declare that we should scrap everything else in Assam and concentrate our efforts upon grabbing more land for Reserves, and one of our former Conservators used to maintain that he thought more of a man

who worked at a loss than of one who made a profit from his Division, because he felt sure that the former was putting more into his forests than he was taking out from them : these views were not meant to be taken absolutely literally, no doubt, but still they would go to strengthen the suspicions of the public that our business instinct is not always sufficently strongly developed, especially seeing that we did manage one year to achieve a deficit in Assam instead of a surplus on our year's working.

The Forest Department is to remain a Reserved Subject, but that is no reason why it should continue to be run on the old bureaucratic lines, and if we can make it perfectly certain that the operations, which we undertake, are the outcome of our corporate digested opinion and not the mere whim of some transient individual ; that they are undertaken in forests where our united experience considers they should be undertaken, and not necessarily in Divisions that are residentially desirable, and that they are conducted by the officers, who are considered most likely to conduct them successfully, and not necessarily by the poor wretches who merely happen to be in charge of those Divisions at the time, *then* we make it perfectly certain that the Forest Department is a reasonable, well-organized business concern, and when the time comes, as come it must, for the Department to be transferred, we can hand it over as a successful going concern, which can continue to go even under still greater democratic control.

There is also this to remember, that the ranks of the Imperial Cadre are going to be filled sooner or later by Indians and statutory natives of India—the results of the last Civil Service examination in London warns us that it may be sooner rather than later—and the advantages, which will accrue from introducing these recruits into an Assembly, which we can be sure will be distinguished for its breadth of view and, let us hope, for its candour, instead of enclosing them permanently in water-tight compartments, must surely outweigh any bureaucratic objections there may be against the establishment of a council of debate.

I have studiously avoided using the expression "Forest Conference," because that has stood for something else in Assam,

where our rare Conferences have been wholly delightful meetings, ending literally in smoke, but Conference is, of course, the right word.

The most obvious and immediate benefit that we would gain by being able to meet and discuss our mutual affairs, would be the dissolution of the Water-tight Compartment System. The splendid and complete isolation, in which D. F. Os. dwell, not only permits them to tender sleepers to the *same* Railway at *varying* rates, and to commit similar business solecisms but prevents them from having any real knowledge of the state of the outside timber market: a chance scrap of conversation with the Forest Economist, as he was hurrying to the Ghat to catch a steamer, once enabled me to put up the price for my sleepers by 12 per cent., and the Railway, from their knowledge of the cost of sleepers elsewhere, were delighted to take them even at the enhanced rate. We are prepared to, and we do, sell our forest produce and lease out the rights over hundreds of square miles without having the foggiest notion of the value of our wares, and we must continue to do so as long as we remain crimped up each in his own little hutch. What a commotion there would be, as the Forest Economist remarked to me, if anyone asked that he might be sent to Calcutta, Calcutta mind you, that Babylon of India, in order to study the timber markets. A Forest Conference in Shillong would not, it is true, put us any more in touch with the outside world, but we would soon discover that our ignorance of an important side of our own business was so abysmal as to necessitate remedial action being taken, before we could dare to dispose of any of the public property entrusted to our charge.

Under the Water-tight Compartment System only accident can ensure the right thing being done in the right place by the right man, for the D. F. O. for the time being has got to carry out any job that is down for his Division, however incompetent for that particular piece of work he may feel himself to be.

Man, being mortal is bound to make mistakes, but under this system he is given an opportunity of making more than his fair

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quota, because he is asked to do things for which he may have no talent—that is bad enough, but what is worse is that we have very little chance individually, and none at all corporately, of realizing our errors and profiting by the experience.

Two striking examples come to my mind.

We were starting taungya plantations in Kamrup and were experimenting with sal and teak, when I happened to stumble upon a number of old teak taungyas, the existence of which had been lost sight of for years and years. The local villagers were able to inform us that no D. F. O. or subordinate had visited the taungyas since 1897, when the big earthquake destroyed the paths leading to them and made them very inaccessible. They furnished us, it goes without saying, with some valuable information regarding the prospects of teak grown under similar conditions, but it is unsatisfactory to think that the experience gained from these previous experiments should only have come to light for present use by a mere accident.

A plantation of *Lagerstrœmia flos-reginæ* was formed in Kamrup many years ago, and yielded certain results, before interest in it was lost and no further care was taken of it. A long time afterwards a plantation of the same species was commenced in Cachar, then in the other Circle, by officers who had never heard of or visited the Kamrup experiment. The Cachar plantation is still being extended, or at any rate was until a short time ago, and it is quite possible, all being well, that in the course of time precisely similar results may be obtained as were obtained twenty and more years ago in Kamrup. Isn't it wonderful?

I hope I shall not be accused of trying to wash some of our dirty linen in public, if I cite cases of past failures in order to illustrate my opinions. It so happens that most of these failures permit of perfectly reasonable explanation, if one had time to give it in each case.

It must sound astonishing, for instance, that plantations of so valuable a species as teak could be lost sight of, but the explanation is simple.

The Divisional Officer, who started and cherished them, died suddenly of Kala-azar. His death was soon followed by the earthquake. Previous to this catastrophe the plantations could be reached by driving roads from two Forest Rest-houses. Both Rest-houses collapsed, the adjacent river changed its course in an amazing manner and its bed was raised some twenty or thirty feet by vast quantities of sand being thrown up: the roads disappeared and the plantations were cut off by deep and dangerous bogs and large lakes of clear water. The accident of being blessed or cursed with a disposition to mooch about in odd corners led me to try and explore the hilly country on the far side of the bogs, and the only way I could get across was by making a local man, who owned an elephant, act as pilot to my elephant, and even then we had to wallow through some most dangerous ground. As soon as we arrived at a teak tree and I asked how it came to be there, the whole story was told me. The written records, if there were any, perished from the earthquake, as all papers were exposed to torrential rain after the offices had tumbled down.

A Forest Conference is not going to prevent earthquakes or prove a cure for Kala-azar, but it would provide us with a continuity of tradition, and assist in the diffusion of knowledge, instead of letting it die with the lone individual who had acquired it.

In the second case the information about Lagerstrœmia was gained in Kamrup and remained there, that was all; Kamrup is water-tight.

Provinces are divided up into Civil Districts for administrative purposes, and it is convenient that Forest Divisions should correspond to these, but that is no reason why the activities of a forest officer should be *confined* to an area that was only designed to mark the limits of jurisdiction of an officer of another branch of the Public Service.

The inequalities between Forest Divisions in Assam have been notorious: some officers have had more to do than one man could possibly see to, and others have literally had to invent little

bits of fancy work in order to keep themselves occupied. I believe I am right when I mention that the first, and for very many years the only, scientific working plan in Assam was that prepared by the late W. R. Fisher in his youth for a few acres of the only sal found in Darrang Division, then the cushiest of cushy billets, while the square miles of sal in Goalpara and Kamrup were not tackled till long afterwards.

The recently increased demand for timber of all sorts may prevent Divisional Officers from being sent to work in other Divisions (having their office work sent them by post), but this could certainly have been done six or seven years ago. The most important Division in the Province is undoubtedly Goalpara, where sal timber worth at least a crore of rupees, according to recent calculations, should be taken out, if only suitable means of exploitation could be devised. It has been the custom to load Goalpara with junior officers and subordinates, but one cannot help thinking that if these juniors and subordinates had been placed in less important Divisions and the senior men congregated in Goalpara, we might now be realizing some of those rupees. Trouble about precedence and so on might arise, but most of us are not babes, not are we proud, and the sticklers could always be embalmed and retained in their proper mummy-cases

One of the most disheartening features of the Water-tight Compartment System is that it inevitably leads to gross injustice being done on occasions to subordinates. Promotion goes according to seniority in the Circle lists, and a subordinate, whose fate deposits him in some snug Range in a Division with nothing to do, is certain of his promotion in due course provided he continues to do nothing well but the unfortunate man who gets let in for arduous departmental operations in an important Division knows that failure to please may bring him a bad mark, that will affect him throughout his whole service. He can expect no special reward if he is successful, but only a prospect of being continually hauled out to do this kind of hard work. It is not so much a case of men not being given equal opportunities of distinguishing themselves, because we give no reward to those who do well, but of

men not being given equal opportunities of failing. What it comes to is that the subordinate, who can keep away from his D. F. O. is safe, but one who has to do important work under supervision stands a fair chance of being marked down as a rotter. It is clear that we would be able to separate the goats from the sheep, if we pooled our resources in men, and would be able to promote those who came forward and did well at their work, over the heads of those who sneaked out of the limelight, and who cannot be passed over at present, because there is nothing *against* them

A properly organized Forest Conference should justify its existence, too, by proving a bulwark against superfluous paper efficiency being demanded of us rather than real efficiency. Though some of us can aver with a clear conscience that we have never bowed the knee to the great god Eyewash, yet we are forced into contact with this unclean monster more and more, and there is a danger lest we should be driven to make our obeisance for the sake of a quiet life. One small and minor instance will suffice. A forest guard in order to draw four annas travelling allowance has to possess himself of a document consisting of two pages of printed matter and two pages ruled for entries: the D. F. O. has to sign this document either three or four times before the money claimed can be drawn. Now, it is quite permissible for the Comptroller to feel *himself* safer, if our valuable signatures are attached three times to subordinates' travelling allowance bills, but some agency is wanted to impress upon him that *the state* is much better served, if we have time to go abroad and see that the journeys claimed for are actually performed and not hatched in the Range Office, as so many are. A certificate to the effect that, for all we know to the contrary, the journey claimed for has been performed (no one could be asked to commit himself more than this) should surely suffice, and a smaller and cheaper piece of paper would obviously meet the needs of the case, because the forest guards can't, and we won't read the printed matter. This is only a small matter, but heavier and equally useless impositions can be thrust upon us by anybody, who likes, and there is no one to object on our behalf. Just think how the knees, however, of a Comptroller or Accountant-

General would wobble, when he arrived with his brand-new form outside a door marked "SOVIET."

At one place that we were at in Germany there were two Forstmeisters, who lived in the same block of buildings. Our old man was a great practical man, and scoffed at the new forms that were added year by year, preferring to see everything that went on in his forests to stewing indoors over paper. His neighbour was the reverse and seldom left his office, with the result that his forests were not nearly so well managed and provided a very wholesome lesson to us of the evils of superfluous paper efficiency. The discussions over what Forest Journals should contain showed that some of us are already tainted. Everybody seemed to have his own idea on the subject, a sure sign that this form was really superfluous, but we were treated to the undignified spectacle of the Conservators sitting round a table in Dehra Dun, wracking their brains to devise something to fit into the Forest Journal for no other apparent reason than that it was already in existence and ought to be filled up somehow. If the Conservators' valuable time had been occupied in seeing what forms could safely have been abolished, we might all be happier men. The necessity of adequate paper efficiency and a certain amount of red tape was proved many times over during the War, when new brooms, who took over offices, sworn to destroy Red Tape and the Hun all at once, found that they merely got themselves into a hopeless mess, and that business was delayed instead of being expedited.

Our forest offices have reached a state, however, where it is essential that we should retain only what is necessary and not what is merely good or nice to have.

Enough has been said to show that our professional efficiency would probably be largely augmented, if we were able to pull together and run the Province as a whole and not according to small Divisions, that were made to fit civilians and not us at all, and beyond doubt we would at the same time score heavily in personal matters, if there was a Conference to look after our interests. I do not mean to say that the Conference would unite us into a form of Union, which we would use as a lever for obtaining personal

advantages from the local administration under a threat of downing tools (at present it would be a case of downing pens), but merely that we would be able to arrange amongst ourselves domestic matters such as taking leave, the posting of recruits, etc., etc., and advise the Conservator accordingly.

This would not be an unimportant side to our business as we have officers serving in Assam, who now realize that they were posted on first arriving in the country merely where their services might for the time being be most useful and with no regard whatsoever to their future efficiency or their personal interests. And if this is true of Imperial officers how much more true must it be of Provincial officers, who have less opportunities than we have of placing our little grievances before the Conservator and of obtaining small concessions from him to suit our convenience. Some apology is due from me for inflicting upon the forest public a matter that might very well have been kept within the Province, to which it refers. My principal excuse is the Editor's persistent demands for "copy," all appeals from me to my brother officers here to sit *down quickly and write something* having been received with stony indifference, but perhaps, after all, conditions may not be so different in other provinces and perhaps this criticism, which is intended to be constructive rather than destructive, may be of some comfort to would-be reformers.

The question, which we might very well ask ourselves, is, are D. F. Os. in the position, as it were, of bank-clerks with a manager over them, whose duty it is to see that each clerk keeps his own ledger up to date, or are we in the position of Directors on a Board with a Chairman of Directors over us? The opinions of his clerks are not taken by the manager because they are not worth having, but the Chairman of Directors conducts the operations of Bank along the lines that the majority of Directors indicate.

## THE MANUFACTURE OF ALCOHOL FROM WASTE WOOD OR SAWDUST.

BY I. H. BOAS, M.SC.

It has been known for centuries that cellulose can be hydrolysed to fermentable sugars and most text-books on organic chemistry represent the change by an equation showing the union of one molecule of cellulose with one of water. The apparently simple reaction is, however, extremely complex and is by no means understood. About 1900 the reaction was first made the basis of a practical process for the manufacture of alcohol. No previous attempt had any measure of success. About this time Klassen patented a process for hydrolysing the cellulose of sawdust by treating under pressure with sulphurous or sulphuric acid.

At last one plant, erected in France, was a success and manufactured a large quantity of high grade alcohol, most of which was used for fortifying Cognac, in place of beet sugar alcohol. The residue after hydrolysis was mixed with molasses and sold as a cattle food. Since that time, several plants have been erected in America. Most of them have not been successful; but analysis of the causes of failure show that in all cases they were largely due to bad design of plant, causing low yields and excessively high overhead charges. In one case, the factory was 80 miles from a railway. In another the extraction plant was so poor that a large proportion of the sugar formed was not extracted. In a third the digestion was so prolonged that much of the sugar formed was caramelized and the digesters were seriously corroded.

These failures have seriously retarded the progress of the industry; but in at least one case a plant has been erected and successfully worked for years. The early failures were to be largely expected, as no one had any experience to guide the design of the plants. The Du Pont Powder Co., on their factory at George Town, had the advantage of the experience of two men who had erected previous plants. This factory turns out 2,500 gallons of a very high grade alcohol per day. The company has

spent much time and money on research, and they have demonstrated that, given proper design and conditions of working, the process is practicable. Briefly the process is to digest the sawdust or hogged wood waste with dilute sulphuric acid in digesters lined with acid proof cement. In twenty minutes to half an hour the reaction is complete and part of the wood substance is converted to sugar. The material is then discharged into leachers, where the sugars are extracted. The clear solution, is then neutralized with lime and allowed to settle. It is then run into fermenting vats and fermented by means of yeast. Finally, the alcohol is distilled off and rectified. There are many difficulties to be overcome. At times the proportion of sugars yielded is quite good, and yet the yield of alcohol is low. This is due to the formation of unfermentable sugars or at least sugars that won't ferment with ordinary yeasts. The French process yielded equally good results with hard or soft woods; but American experience shows results in favour of the latter. The chemistry of the process is so obscure that it is difficult to find the reason for this.

The average yield of alcohol per ton of dry sawdust is about 20 gallons. This is considerably lower than from potatoes or grain or molasses, and thus a larger plant is required for a given output. On the other hand, the first cost of sawdust is nil, while that of other materials is considerable. Much research is needed to find methods of improving the yield. It is very desirable also, that complete investigation of the sugars formed should be made. It is probable that when this is done, methods to promote the fermentation may be established. A beginning has been made on these lines at the F. P. L. Madison. A still more fundamental research is being made at Berkeley University, San Francisco, with the constituents of the wood. When this is better known, it will be possible to proceed on more sure lines in devising better methods. As far as Australia is concerned, the yield from our hard wood sawdust has not been investigated. The problem is of the utmost importance to the Commonwealth, in view of the necessity for replacing petrol by another form of liquid fuel. All the world over this problem is pressing, and in

Australia where there are no local supplies of petrol, it is especially so. Alcohol is the only substitute in sight. Its suitableness has been demonstrated and all the engineering difficulties overcome. The Forest Products Laboratory will early take up the question of utilizing some of the waste sawdust for this purpose.—[*The Australian Forestry Journal*, Vol. III, No. 9.]

## NATIONAL *VERSUS* STATE CONTROL IN THE U. S. A.

We have received a copy of correspondence which has passed between Mr. Gifford Pinchot, Commissioner of Forests, Pennsylvania, and Col. W. B. Greeley, the United States Forester, on the subject of State *versus* National control of forestry and the lumber industry.

Col. Greeley supports State control as the best and quickest means of getting the necessary work done by making use of the State forest organizations as active agencies in preventing every form of devastation and especially that of fire. In support of his view he states that actual accomplishment in timber production will, for a long time to come, be measured by the reduction in the yearly acreage of forest fires and the records just compiled for the last fiscal year show a recorded total of 27,000 forest fires and 8,500,000 acres of forest land burned over. One of the greatest forest resources which the country has, he continues, is the 130 odd million acres of land containing young growth in various stages. This, with the areas of second growth timber of merchantable size, must bridge the gap between the exhaustion of our virgin forests and our adjustment to a sustained yield. Millions of acres of these young stands are being wrecked by fire every year. He writes, "It seems to me beyond question that our immediate efforts and the character of the legislation we seek should be bent towards reducing this fundamental cause of forest devastation."

Mr. Pinchot, while agreeing in the main as to the pressing necessity of taking action against forest fires, states that that is aside from the main issue. He advocates giving forestry through national action, a wider importance in each State, and increasing

its powers. Under the national plan, which, he says, is now approved in principle by a majority of the professional foresters of the country, the Federal Government would control the harvesting of commercial forest crops. That would involve the prevention of destructive lumbering, protection of young growth already on the ground, simple measures for securing natural reforestation and slash disposal on the cut-over land.

He strongly advocates Federal control because State control in the first place would involve delay and even if it could be enacted would not have the same effectiveness as a regulatory measure.

The above opinions are of interest to Indian foresters who have seen the gradual decentralization of control over the forests by the Government of India and its transfer to the various provincial governments. There is, however, an important distinction between the problems of forest control in America and in India in that, in the latter, the policy, from the outset, has been to preserve a sufficient area of forest for the physical, commercial, and domestic welfare of the country and its people. This policy has been in the forefront of our past endeavours and there is still a great deal to be done to complete the work already so well advanced.

As soon as a forest is reserved every effort is made to improve its forest capital. Ours has therefore been a work of preservation, restoration, or improvement, and as the result of 50 years of our labour we are now in a position to increase the yield, develop new sources of supply, and so increase our revenues. In America the policy of preservation only came in after heavy inroads had been made in the forest capital, a great deal destroyed by fire and much of the forest land had been alienated. The problems before American foresters are therefore vastly different from our own and while decentralization of control, as has taken place in India, has distinct advantages it would appear that only by a central directing agency can the policy of formation of a permanent forest estate in the interests of the country and people as a whole be accomplished. There is the danger that in leaving the decision to

local authorities the national as opposed to the local stand-point may be overlooked.

It would be of great interest to our readers if some one fully acquainted with the organization of the federal and State Forestry departments in the U. S. A. would give us a full description, as well as a frank criticism, of the exact relations between the two agencies and how any conflict or overlapping is prevented.

LOGGING IN THE DOUGLAS FIR REGION, BY WILLIAM H. GIBBONS, U. S. DEPARTMENT OF AGRICULTURE, BULLETIN, No. 117, GOVERNMENT PRINTING OFFICE, WASHINGTON, 1918.

This Bulletin deals in considerable detail with the whole subject of the extraction of Douglas Fir in the region of its highest development.

Forest officers who are already acquainted with the general aspects of the subject as dealt with in Bryant's "Logging" and Leete's Report on "Lumbering and Woodworking Industries in U. S. A. and Canada" will find many points of interest in this Bulletin. While much of the information given has no direct application to Indian conditions, there is much to be noted for consideration by those who have to contemplate the introduction of mechanical means of extraction for concentrated fellings. It should have a place in the library of every Utilization Circle.

To start with, the sections on Breakage, Waste in Bucking (cross-cutting), Factor influencing cost, Filing, Supplies and Replacements deserve attention as they lead to the consideration of several points which are often neglected in departmental working.

The main portion of the Bulletin is taken up with a close examination of the various methods of skidding or yarding and goes over much the same ground as Bryant in his "Logging," but the minor points about the actual working of these systems which are brought out in the Bulletin are of great importance and deserve close consideration. A number of very useful tables are given in these sections although where costs are given it is probably necessary to double those shown throughout the Bulletin.

The sections which will probably be of most interest in India are those on Logging Railroads. They give a mass of information which has, so far as we know, never been assembled and made so readily accessible before. Here again there are a number of useful tables which should prove very useful in India for estimating the working costs of extraction schemes when trained logging engineers are not available. The sections on Railroad Inclines

should prove useful in connection with tram lines in the Himalayan forests as a means of avoiding the interruptions and handling expenses entailed by the use of slides to get over bad gradients. Their operation appears much simpler than one would be disposed to think on general grounds.

The remainder of the bulletin which deals with unloading and water transport is of less interest in India where the amount of material to be handled is not likely to reach the amount contemplated by the author and where our water transport has reached a point of development suited to local conditions.

The writer is to be congratulated on having produced such a useful work, which has so much value outside the region of its immediate application.

The book is illustrated with a number of useful cuts but is marred by the lack of an index.

W. A. R.

shortened to a varying extent by moving the plant on trucks into a dark chamber at an hour in the afternoon and allowing them to remain till some hour after sunrise on the following day. In the various tests the length of exposure to light was varied from a minimum of five hours per day to a maximum of twelve hours and the results of the experiments go to show that both the rate and extent of the growth attained by the plants and the time required for reaching and completing the flowering and fruiting stages are profoundly affected by this variation in the length of the daily exposure.

In vegetative development it was found that the extent of growth was proportional to the length of the daily exposure to light and it was the *extent* more than the *character* of growth which was chiefly affected.

The results in regard to sexual reproduction were even more important. It was found that the flowering and fruiting stages were attained only when the length of day fell within certain limits and in the absence of this favourable length of day, vegetative development continued more or less indefinitely, thus leading to the phenomenon of "gigantism," which is the name given by the authors to abnormal vegetative growth. On the other hand, under the influence of a suitable length of exposure to sunlight, precocious flowering and fruiting could be induced.

The question is asked whether this response to differences in the length of day is not a principle of general applicability in biology. It has occurred to the writers as more or less of a side issue that possibly the migration of birds furnishes an interesting illustration of it.

It is not surprising that the authors also conclude that the seasonal range in the length of the day is an important factor in the natural distribution of plants, at least so far as northward and southward distribution is concerned.

A number of experiments were also carried out to test the value of light intensity. Cloths of different weave were used to shade the plants but it was found that intensity within the range from full normal sunlight to a third or fourth of the normal and

even much less is not a factor of importance. Our silviculturists may have something to say to this in relation to natural regeneration of Sal.

These discoveries are almost certain to throw light on many problems now attracting attention in this country. It is obvious that investigations can be directed in two divergent ways towards the conditions favourable to (1) gigantism and (2) reproduction. In the steep valleys of the Himalayas some interesting data could be obtained by comparing the timber on the higher slopes with that deep in the valleys. It may be that before long we shall have another datum added to our tree description, that of its "sunlight optimum," given in hours, or perhaps we shall have two, one most suited to timber growth (" gigantism") and one most favourable to reproduction. The measurement of sunlight being the simple matter it is, it would look as if with a few more data regarding species we could add considerably to our knowledge of the suitability of species to localities.

The publication is altogether an interesting and valuable contribution to the literature on the subject.

VOLUME XLVII NUMBER 4

# INDIAN FORESTER

*APRIL, 1921.*

## THE SIGNIFICANCE OF SEASONING IN THE UTILIZATION OF INDIAN TIMBERS.

The conversion of the timber resources of India into the common forms of commerce and everyday use is beset with tremendous difficulties imposed by nature. A high potential value may well be placed upon the excellent timber trees of the country, but the climatic conditions under which they must be converted, seasoned and used, tend to rob them of their sterling qualities and to reduce them to a level of mediocrity. The same mechanical and physical properties of many Indian timbers which should make them especially valuable in industry render them difficult to season and unable to withstand without great depreciation the extremes of dryness and moisture characteristic of the Indian climate.

That the situation thus outlined is not theoretical is only too evident. The behaviour of refractory wood under the influence of adverse climatic conditions of India during seasoning leaves its stamp on both forestry practice and the development of wood using industries. At the present time there are only a few kinds

of timber that season so easily and well that they may be economically utilized as lumber. A much larger number are considered inferior for the more profitable forms of utilization because they do not lend themselves to the known seasoning methods. This of course results in a drain upon the supply of the less exacting species such as Teak, Deodar, Padauk, Sissoo, Toon, etc. Methods of seasoning must be evolved for all timbers of the forest or else the silviculturist in his plans will be compelled to disregard the larger number of species and limit his energies to the propagation of the relatively few which can be seasoned and utilized. And the difficulty comes even closer to our attention. The wood-work in our homes, and public buildings cracks and pulls apart, the furniture splits and weakens, doors and desk tops warp and twist so that good joinery and workmanship are almost out of the question. The use of wooden wheels for motor cars, gun carriages and similar vehicles is made difficult because of the tendency of the spokes to shrink and loosen. Wood is imported from abroad when tight fitting wood-work or wooden parts are required although the wood thus imported is intrinsically no better than a score of Indian woods if properly seasoned. Wood-working industries in India are kept from their fullest development and expansion because of the uncertainties of the behaviour of Indian woods after manufacture.

Research work in this connection is under way at the Forest Research Institute at Dehra Dun to ascertain the proper methods of seasoning the different kinds of wood so that they may be fit for use under the varied climatic conditions of the country. From the results obtained along the line of timber seasoning in England, America, Canada and Australia there is good reason to look for success in India even though the problem is much more complex here than elsewhere. The fundamental principle which must be considered is that when wood is seasoned to the extent that its moisture content is in equilibrium with the surrounding atmospheric conditions it will not crack, warp, swell nor shrink except as the atmospheric conditions change. It is therefore important to season wood to jus such a point as will bring it into complete

equilibrium with the climate in which it is to be used. Many serious difficulties with wood and wooden parts involving the success of large projects are caused by disregarding this principle. Wood which is thoroughly seasoned for one region or for one period of the year is not necessarily thoroughly seasoned for other places or other seasons. It is common practice to ship timber, "thoroughly seasoned," from one section of the country for use in another section with different climatic conditions. Under such circumstances the wood proves unsatisfactory because it "shrinks" and warps excessively and the timber itself unjustly receives a bad reputation. If the timber has been seasoned for the climatic conditions under which it was to have been used, satisfaction would have been realized. Research has shown the relation existing between the moisture content or humidity of the atmosphere and the moisture content of wood in equalibrium with it, so that a simple test determines whether or not the wood is actually seasoned to its use and climate.

However, the actual seasoning to the predetermined point is not so simple. The conditions which are suitable for one kind of timber are not suitable for other kinds, so that a great amount of investigative work must be carried out before the best method of seasoning each wood will be known. The margin of safety in seasoning many hardwoods is extremely slight. If the process goes on too quickly the wood cracks, splits and warps: if it goes on too slowly the wood becomes stained, lifeless and decayed.

Experiments have been under way for the past five years to determine the proper practice to be followed for different species by natural seasoning. These tests involve many commercially important species and various extremes of climatic conditions. At present there is much difference in opinion and practice as to the best method of seasoning timber "naturally." The weakness of all the present methods of natural seasoning is that it is impossible to control the elements of nature or to make them sufficiently constant for refractory woods. A beneficial or favourable condition for seasoning is followed by one quite detrimental, or an unfavourable condition is at hand at a time when the mos

favourable is required for success. Thus it is necessary to develop and use mechanical apparatus for seasoning artificially whereby the drying conditions, although the same as those of nature, are brought under control. Thus the optimum conditions may be maintained constantly from day to day or month to month. In this way the wood is seasoned more quickly and more uniformly than by nature's process. There has been much prejudice among wood-workers and manufacturers against artificial methods of seasoning and the objections have been justified by the results obtained from early attempts. However, in the light of present day knowledge methods have been developed to produce excellent results so that prejudice is quickly dispelled.

During the war when the shortage of air seasoned wood for use in aircraft construction, gun carriages, army vehicles of all kinds, gun stocks, etc., was felt in Europe and America, scientific workers proved conclusively that wood green from the log can be seasoned as successfully artificially as by natural methods, in many cases more successfully and always with a great saving in time. The result of such work carried out on a commercial scale has been such that much of the prejudice against artificial seasoning or "kiln drying" has disappeared. Several English and American saw-mills are now equipped with dry kilns to season all timber artificially rather than to air season it in their lumber yards, as has been the practice heretofore.

The American methods of lumber seasoning hold important lessons for India although there is much to be done in modifying the essentials of such practice to meet conditions here. The circumstances which impelled the Americans to push their research work for the improvement of commercial practice were not entirely unlike the conditions in India. The utilization as lumber of several important timber trees such as red gum, larch, tupelo and the swamp oaks depended entirely upon finding some method of seasoning them without excessive degrade and loss. And the marked indoor seasonal changes in atmospheric conditions from dry to moist brought about quite artificially by the use of furnace heat to overcome extreme cold in winter have

somewhat the same effect on wood-work as the extremes of Indian climate.

In view of magnitude and importance of the seasoning problem confronting those attempting the close utilization of Indian timber resources, a research officer of the Forest Research Institute was detailed last year to the study of methods in use of England, America and Canada. He was empowered to engage a seasoning specialist to work on the problem in India and also to purchase the necessary apparatus required for comprehensive investigative work. A specialist from the research laboratories of the United States Forest Service was engaged and has since arrived in India and taken up his work at Dehra Dun. Plans are under way to install the necessary apparatus in the near future so that after the necessary preliminary work has been carried on at the Institute definite assistance may be offered the industries and Forest Department in the solution of their timber problem.

C. V. SWEET,
*Officer in charge, Seasoning,*
*Forest Research Institute.*

The articles by Mr. Wood and Mr. Smythies on this subject in the *Indian Forester* for August 1919 and August 1920, pp. 403 and 381, respectively, appear to have been inspired, in part at least, by the idea that an attempt was likely to be made to force the application in sal forests, on a large scale and in opposition to the wishes of local officers, of a system of management to which there seemed to be serious objections.

In the article published in the *Indian Forester* for March 1919, pp. 119—132, I did indeed suggest that the principles of the system therein described were believed to be applicable "to the average fairly well stocked sal forest on loam, in places where frost damage is to be feared, where the dying back of seedlings is a marked characteristic and where the establishment of vigorous seedling growth is at present a slow and uncertain process." It was, however, pointed out at the same time that modifications in the system

based on these principles would no doubt be necessary to suit local conditions, *l. c.* pp. 126, 131, 132, and all that was asked was that an effort should be made to apply and test the suggested group-*cum*-strip system "in one or two selected forests." The article in question was, I am afraid, not quite as clear as it might have been and this, no doubt, is entirely responsible for the misunderstanding. In the first place, therefore, I want to make it quite clear that what I wished to do was, if possible, to persuade local officers to give the suggested system a fair trial, as an experimental measure, on quite a small scale, in one or two selected areas where there seemed to be a reasonable prospect of success. This obviously need not, in any way, prejudice the introduction in other forests of other systems or trials with other methods of regeneration and it was never intended that it should do so.

With these preliminary remarks, some of the important points raised by Messrs. Wood and Smythies now require to be considered. The most important objection to the system elaborated by Mr. Wood is that of the inadequate labour supply which is no doubt a very real and formidable difficulty. Mr. Wood, however, has himself pointed out an obvious remedy, *viz.*, that, where the necessary labour is impossible to obtain, seedlings can first be brought on to the ground under shade by relying on natural seed (which could be assisted by such measures as the removal of the soil covering of dead leaves by judicious firing) and that the further development of such 'advance' seedlings might then be accelerated and blank areas regenerated by providing suitable conditions of side shade and soil moisture by clearing the overwood in small patches and narrow strips. This procedure would also meet the further objection which has been raised as regards the probable difficulty of getting an adequate supply of seed annually for artificial sowings on a large scale.

Mr. Wood suggests that we should try to discover the factors which cause the sudden vigorous growth of seedlings which, having developed under shade, are subsequently exposed to overhead light. Is not this rapid development merely a question of age and root development? Seedlings which have sent their roots down

to permanently moist layers of soil are able to take full advantage of the light provided by a removal of the overhead cover, whereas those which have not done so are then liable to be killed by, or die back from, drought. It is, I think, usually accepted that seedlings which have developed under shade and have produced a shoot of about 3½ feet in height in the shade may be safely exposed without fear of damage from drought.

If care is taken to provide favourable conditions of moisture and side shade in small patches and narrow strips, it is believed that shade seedlings with a shoot of only 15 inches in height could safely be exposed to overhead light without fear of damage from drought.

Mr. Smythies thinks that the system suggested by me must be put out of court because it is only practicable when it is possible to carry out intensive weeding and tending in the rains. One of the chief points of the modified group-*cum*-strip system advocated is that it is believed to obviate this necessity. The fellings are made first in the form of small patches in which dense weed growth does not usually establish itself rapidly on account of the heavy side shade, and these patches are subsequently extended in the form of narrow strips. Experience in the Dehra Dun experiments has shown that, in a well stocked forest in which a dense growth of grass has not yet established itself, a dense weed growth is not likely to occupy the soil for two years after the clearing of a narrow strip. The effect of side shade in diminishing the vigour and density of weed growth, in improving the moisture of the soil and in preventing the hardening and compacting of the soil surface is at present not sufficiently appreciated in India. It is believed that, under the system suggested, intensive weeding or breaking up of the soil surface *during the rains* will not be essential and that in the smaller areas two weedings and in the larger areas four weedings, in all, will probably be sufficient. This, however, obviously requires to be tested in different localities under different conditions of weed growth.

Mr. Smythies says that all my experiments were located in an exceptionally favourable type of forest. The result which I

think most impressed the numerous forest officers who saw those experiments from time to time was not so much the good growth obtained in the cleared areas as the extraordinary poor development obtained in the shade. So much so indeed was this the case that the opinion was frequently expressed that it was unfortunate that such an unfavourable locality had been selected, which was near the western limit of the sal's distribution in northern India and where the soil conditions appeared to be exceptionally unfavourable for the development of seedlings.

The primary problem given to me to solve was to discover the chief factors which caused the dying back of sal seedlings and, if possible, to find some means of accelerating the development of seedlings in the forest. The Lachiwala forest was selected for the preliminary experimental work for the following reasons:

(*a*) dying-back was a marked characteristic of the seedlings there,

(*b*) the locality was one where forest damage was to be feared,

(*c*) the forest was conveniently situated for constant inspection from Dehra Dun at all seasons of the year.

At the same time, it was thought that, if the factors at work in this locality could be satisfactorily identified, this would at all events be a step in the direction of helping officers to solve the regeneration problem in other forests which are characterized by the dying back and unsatisfactory development of seedlings and where, therefore, similar factors might be at work. We know a good deal more now about the problem of sal regeneration than we did when the Dehra Dun experiments were first started in 1912 and, in the light of our present knowledge, it is no doubt possible to design far better and more fruitful experiments. At the same time Mr. Smythies is mistaken in thinking that the advisability of diminishing weeding and tending in the rains was not kept in view. Two of the experiments described in the *Forest Record* now in the press (of which the final proof has been passed and which will it is hoped shortly appear) were undertaken with special reference to this particular point, at the suggestion of Mr. Clutterbuck, and

the entire series of experimental results obtained in Dehra are very largely due to the kind suggestions of the latter and to his unique knowledge of the sal forests of northern India. Mr. Smythies' error, however, is no doubt entirely due to my delay in publishing the full account of the experiments in question, which has been caused by my absence from India on long leave. In any case, however, it is obviously desirable that the results obtained at Dehra Dun should now be tested by local officers in other localities on a somewhat larger scale and it is for this reason that I still persevere in the hope that local officers may be persuaded to give the system a careful trial, on a small scale, in one or two selected areas.

Mr. Smythies notes that strip fellings on a programme drawn up by me have been tried in the United Provinces and have proved to be a failure. He refers presumably to the experiments in the Jaspur sal forests of Ramnagar. These forests are altogether exceptional, being unusually open and with a dense established growth of grass. In the note which I wrote on these forests in 1915 and on which the subsequent experiments were based, I emphasized the fact that in these forests the primary problem is to prevent denudation by "securing a more uniform distribution and percolation of the rainfall in the soil of the forests as a whole." The experiments suggested by me, therefore, provided for hoeing the soil, for making shallow contour trenches to catch the rain water, dead leaves and *débris* and for establishing a denser forest growth in the dry *Kokat* areas on the ridges and plateaus. I hope soon to have an opportunity of seeing the results of the experiments which were actually carried out and of studying the details of the work done and observations recorded. Until this has been done it would be obviously unprofitable to attempt to discuss these results. Whatever these results may have been, however, it is surely unreasonable to base upon them the rejection of a suggested experimental trial for the system of group-*cum*-strip fellings, in view of the exceptional nature of these open forests which are characterised by the dense established growth of grass. In the article published in the *Indian Forester* for March 1919,

pp. 125, 126, with these and similar areas especially in my mind, I pointed out that it was not proposed at present to apply the suggested system to "semi-ruined areas, poorly stocked and with little or no undergrowth except a heavy growth of grass, such areas being exceptional and requiring special treatment."

It seems to me that no system of management for sal can be regarded as really satisfactory or permanent unless it enables us to establish seedlings quickly and with reasonable certainty on areas where at present no seedlings exist. At present our knowledge is not sufficient to enable us to devise such a system for the various types of sal forest and we have to do the best we can, at present, with temporary systems. It is because I think that a careful trial with the modified group-*cum*-strip system may materially increase our knowledge of the problem and may bring us considerably nearer to the goal of at least one really satisfactory system that I now venture to urge once more the desirability of carrying out this trial in one or two small experimental areas. The fact that we have a great deal of advance growth of unknown age in many of our forests, most of which started growth during, or shortly after, an era of more or less frequent fires and when the forests, as a whole, were probably more open than they now are should not, I think, be allowed to distract our attention from, or prevent our working at, the solution of this primary problem, provided that this does not interfere with the present realisation of a justifiable annual yield from the existing crops.

The primary principle which I am now trying to advocate is that the regeneration fellings should be carried out in such a way as to secure, as far as possible, the most favourable conditions of soil moisture for seedling development throughout the year (this being a factor of vital importance in the case of sal) and at the same time to avoid the risk of damage from frost development. The modified group-*cum*-strip system appears to be one method which may enable us to do this and a careful trial for it is accordingly asked for. There are no doubt areas where such a system cannot be successfully worked and where,

for instance, it may be advisable in consequence to try the ordinary uniform system. Even here, however, it may still be possible and advisable to adopt the above principle, at all events partially, by carrying out artificial sowings in small cleared patches where no natural seedlings have established themselves and by removing the overwood above natural seedlings chiefly in the form of small groups or narrow strips.

In the Uniform Working Circle of the Haldwani Division referred to by Mr. Smythies, attempts are, I think, made during a period of 20 years to bring seedlings on to the ground in Periodic Block 2 by burning off the dead leaves and by keeping the cover sufficiently dense to prevent a heavy growth of weeds. Is there as yet any definite evidence to show that this can be relied on to establish (after a period of average seasons and not only in an exceptionally favourable year like 1913) a full stock of seedlings, where none existed before, which will then be sufficiently vigorous to stand exposure by removing the overwood in the regeneration fellings proper without special reference to damage by frost or drought? Even if this is the case in Haldwani, is there any evidence to show that this will be the case in other localities where damage from frost or drought Is more severe? If such definite evidence is not yet available, ought we not to experiment on the lines now suggested with a view to accelerating the establishment and development of seedlings by carrying out artificial sowings in, and by exposing natural seedlings to overhead light in, small cleared areas under the most suitable conditions of moisture and side shade?

It seems probable that *if we choose to wait long enough* a full stock of sal seedlings could eventually be obtained in the shade which would be sufficiently strong to withstand complete exposure caused by the clear-felling of extensive areas, even in a frosty locality. In the Dehra Dun experiments, it has been found that, in a cleared square with a side of 180 feet, in a frosty locality, coppice shoots of sal have survived without serious damage from frost and are now 17 to 20 feet high at an age of 5 years. It seems possible that, in such old plants, the strongly developed,

deep-going, root system, being in contact with the deeper warmer layers of soil, the temperature of the comparatively warm water rising into the stem and leaves may be sufficient to diminish danger of frost damage. This point requires further study but in any case the real question at issue is, are we justified in acquiescing in the long delay necessary to produce such well developed plants in the shade or ought we not to do our utmost to accelerate the seedling growth?

A subsidiary question in this connection which also needs study is whether a tree which has passed through a long period of very slow growth under shade and which then grows with great rapidity after exposure to overhead light is as satisfactory with reference to the ultimate dimensions attained, the quality and durability of its timber and in other respects as a tree which has developed more uniformly from early youth with little or no dying back.

In conclusion, it is interesting to note that strip fellings and the question of providing adequate side shade and soil moisture for seedlings are now beginning to attract the attention of several forest officers in India. Thus Mr. the Hon. J. W. Best in discussing the teak plantations of Berar has recently expressed the opinion that "clear felling in strips is likely to lead to the best results," see *Indian Forester* for August 1920, p. 431, Mr. F. K. Makins, also, remarks as follows regarding the reproduction of sal in Singhbhum, " the principal adverse factor in the growth of sal seedlings is drought * * the amount of deposition of dew and its rate of evaporation probably have an important influence on sal reproduction * * every advantage ought to be taken of this important factor in future regenerative operations and with this object experimental plots have been laid out to test the effect of clear felling in strips against the morning sun," see *Indian Forester* for June 1920, pp. 293, 294. Again, Mr. S. H. Howard in his Working Plan for the Ramnagar Division of the United Provinces (Allahabad, 1919), p. 18, writes that serious damage from drought is " confined to germinating seeds and to seedlings * * where sal regeneration is difficult to

obtain probably the best method is one of clear felled strips with a percentage of artificial regeneration."

R. S. HOLE.

*5th February* 1921.

## TAPER CURVES AND CONSTANTS FOR SAL.

BY E. A. SMYTHIES AND S. H. HOWARD.

A problem which frequently faces a Divisional Forest Officer is the taper of standing trees. The volume of timber obtainable from standing trees can be calculated by multiplying average length of exploitable bole by the mid diameter without bark. The more usual method by form factors is impossible at present as the form factors are not known. The first factor can be quickly and readily estimated by eye, or, if greater accuracy is required, measured by instruments. The diameter measurements over bark at breast height can also be easily obtained, and the

estimator has then to guess the taper of the trees, and also the necessary deduction for bark thickness to obtain his required data. There is a simple method of obtaining a taper table for all engths of bole and for all diameters which may prove of interest to Research Officers, who, in measuring up statistical sample plots, do all the necessary work to give accurate enough results.

In measuring sample plots, it is necessary to fell sample trees and to measure (1) their diameters at breast height over bark, (2) the mid diameters of 10′ logs of the bole without bark, *i.e.*, at heights up the trees of 5′, 15′, 25′, 35′, etc. After a series of trees of the same species and approximately the same quality class have been measured, the results are plotted for each height separately with diameter at that height without bark as ordinates and the breast height diameter over bark as abscissæ. The mean curve is drawn through the points thus obtained (which curve will usually be found to be a straight line). An actual example of this curve for good qualities Bhabar sal is given to illustrate what is meant. Such curves are drawn for heights of 5′, 15′, 25′, and 35′, (and 45′ if considered necessary, but merchantable boles of 90′ are rare).

These curves give the data for reading off the diameter without bark at any of these heights for all breast height diameters. The readings can be tabulated for those diameter or girth classes most usually employed by the Divisional Forest Officers. The table for good quality Bhabar sal is given below :—

| Breast. | Height over bark. | | Diameter without bark in inches at height of section. | | | | REMARKS. |
|---|---|---|---|---|---|---|---|
| Girth class. | Mean girth. | Equivalent diameter. | 5′ | 15′ | 25′ | 35′ | |
| 3′—4′ | 3′—6″ | 13·1 | 11·5 | 10·1 | 9·2 | 8·5 | Note.—Mean girth has been converted to mean diameter, *not* by $\frac{1}{\pi r}$ but by multiplying by the constant ·3119 which has been found to be the correct factor for sal generally. |
| 4′—5′ | 4′—6″ | 16·8 | 14·7 | 13·0 | 11·9 | 10·95 | |
| 5′—6′ | 5′—6″ | 18·1 | 18·1 | 15·95 | 14·6 | 13·5 | |
| 6′—7′ | 6′—6″ | 24·3 | 21·4 | 18·8 | 17·3 | 16·0 | |

Plate 5.

## 5' SECTION CURVE.

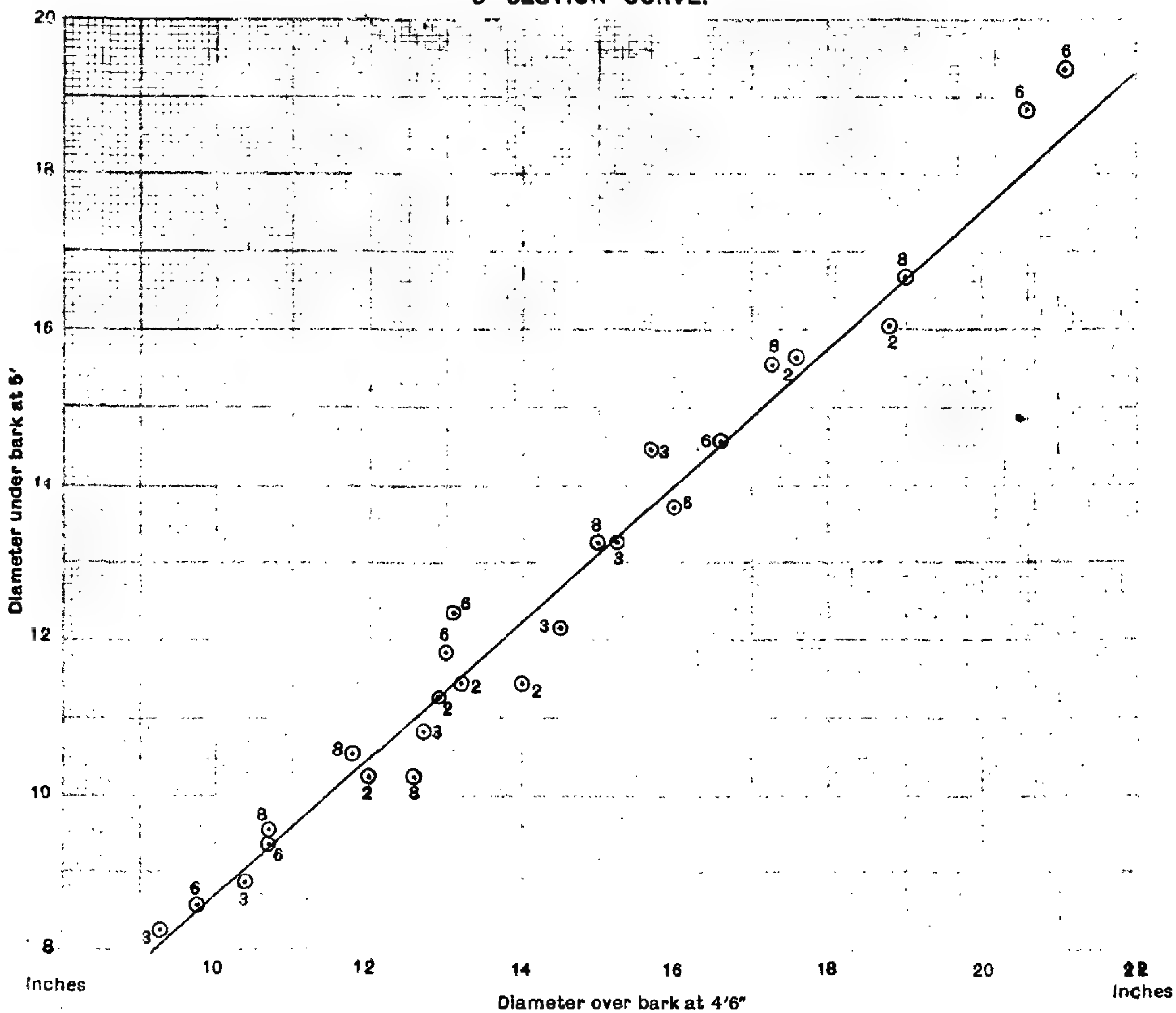


Photo. Zinco., January, 1921.—No.2340-856

This gives a very useful table to the Divisional Forest Officer. It may not be true for individual trees, which are always liable to have their own eccentricities, but it will be accurate for the average of groups, and could, for example, be used for calculating the volume of coupes or sale lots of that average quality.

It is, however, advantageous to go further, since the average length of merchantable bole is not likely to be exactly 10′, 30′, 50′, or 70′. Perfectly good curves for each girth class can be plotted on these points, which would give readings for all lengths of bole within that range, but it has been found that the factor of taper for sal is a constant for all diameter or girth classes which enables us to go considerably further still.

Take the above table, and for any height, say 15′, it will be found for all sizes of trees from 3′ 6″ to 6′ 6″ that the ratio

$$\frac{\text{breast height diameter over bark}}{\text{diameter at 15' without bark}} = \text{a constant C.}$$

For the 15′ height, for a tree 13·1″ diameter $c = \frac{10\cdot1}{13\cdot1} = \cdot772$

| | | | | |
|---|---|---|---|---|
| Ditto | 16·8 | „ | $c = \frac{13\cdot0}{16\cdot8}$ | = ·774 |
| Ditto | 20·6 | „ | $c = \frac{15\cdot95}{20\cdot6}$ | = ·774 |
| Ditto | 24·3 | „ | $c = \frac{18\cdot8}{24\cdot3}$ | = ·776 |
| | | | average | ·774 |

Similarly for any of the other heights.

If these are worked out, the constants for the different heights will be obtained as follows :—

| | | | |
|---|---|---|---|
| 5′ | height | = ¼ (·87 ·87 ·88 ·88) | = ·875 |
| 15′ | „ | = as above | = ·774 |
| 25′ | „ | = ¼ (·70 ·71 ·71 ·71) | = ·708 |
| 35′ | „ | = ¼ (·65 ·65 ·65 ·66) | = ·653 |

From these points, a curve showing the constant factor of taper at all heights (for all sizes of trees within our limits) can be drawn. This curve is attached, the constants being plotted

3

as ordinates and heights as abscissæ. It should be emphasized that this curve of constants can be used for any girth or diameter.

To illustrate its use. Take any height of bole, say 36′. The mid height is 18′, and the constant for 18′ is ·753 (read from the curve). Take any diameter, say 16·3″. Then for a tree of 16·3″ diameter over bark at breast height, with a bole of 36′, the diameter under bark at half the height of the bole, 18′, will be 16·3 × ·753.

For the facility of all who may require to use this information, we have tabulated below the taper constants for different heights. This table will be generally applicable to good quality sal Bhabar forests, within the limits of 3′ × 7′ girth, or 12″ and 30″ diameter, the degree of possible error when applied to large numbers being under ½″ in girth and under ·1″ in diameter.

Table of Taper constants for good quality Bhabar sal :—

| Mid length of bole in feet. | Taper. constant. | Mid length of bole in feet. | Taper constant. | Mid length of bole in feet. | Taper constant. |
|---|---|---|---|---|---|
| 5 | .878 | 15 | ·773 | 25 | ·708 |
| 6 | .862 | 16 | ·765 | 26 | ·702 |
| 7 | ·850 | 17 | ·757 | 27 | ·696 |
| 8 | ·839 | 18 | ·750 | 28 | ·690 |
| 9 | ·828 | 19 | ·743 | 29 | ·684 |
| 10 | ·818 | 20 | ·737 | 30 | ·678 |
| 11 | ·808 | 21 | ·731 | 31 | ·672 |
| 12 | ·799 | 22 | ·725 | 32 | ·666 |
| 13 | ·790 | 23 | ·719 | 33 | ·660 |
| 14 | ·781 | 24 | ·713 | 34 | ·655 |

It may be pointed out that the constants can be applied indiscriminately to breast height diameters or girths. Similar tables will be prepared in due course for other qualities of sal and for other species, as data become available.

Plate 6.

TAPER CONSTANT CURVE.

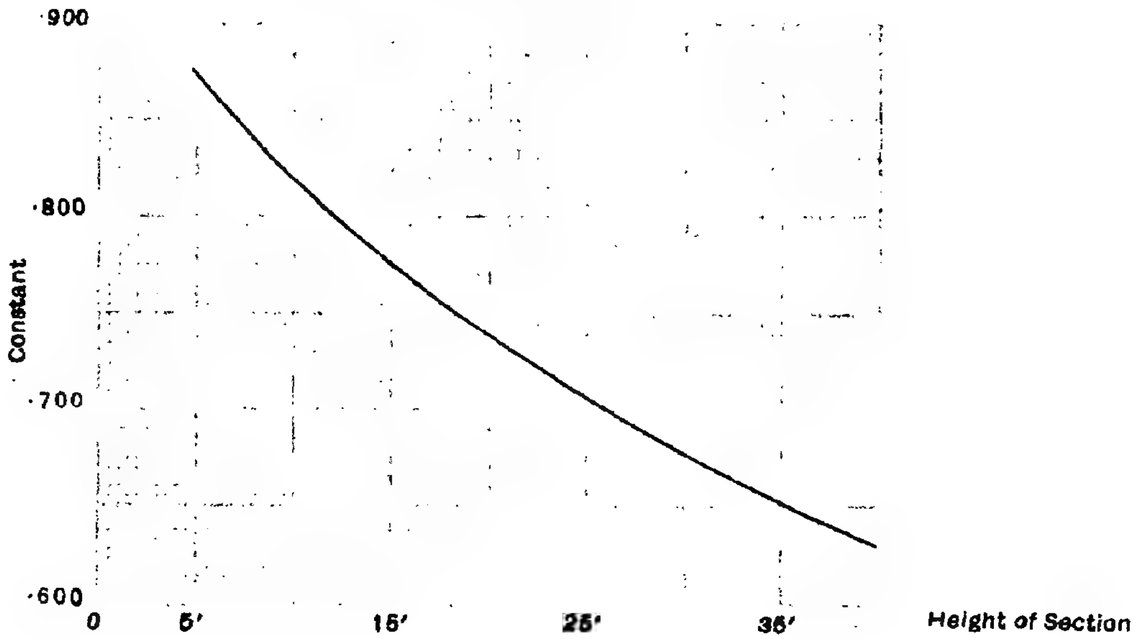


Photo. Zinco., January, 1921.—No. 2340-I: 656

## STUDIES IN FRENCH FORESTRY.

BY T. S. WOOLSEY, JR. & W. B. GREELEY. JOHN WILEY & SON, NEW YORK, 1920.

This volume provides in a convenient bulk a very interesting survey of French forestry.

The object of the authors is to present to American readers the benefits which have accrued to a democratic country through systematic scientific forestry and the means by which these results have been obtained.

On this account the relation between the forests and the local population is continually under reference and although written by a trained forester the usual reproach that these relations have been considered only from the strictly forest point of view cannot be cast at this book.

The introduction and Chapters I and II—dealing with the general aspects of Forestry and Chapter VII on the Control of Erosion where the subject of grazing is frequently mentioned are particularly to be recommended to the general reader. In India they might be studied with advantage by the members of the new Councils who will no doubt be urged by many of their constituents to press for relaxations of our existing forest regulation.

For the trained forest officer the book naturally does not present anything startlingly new but to any one contemplating a tour of study in France, its perusal will supply many suggestions as to the regions best worth visiting and the particular problems to be solved in each of them.

Certain minor blemishes must be noticed. The book is printed on highly glazed paper presumably on account of the photo illustrations in the text but their number is hardly large enough to make the use of this paper imperative while the glaze makes the reading of the copious notes and interesting appendices in small print very trying to the eyes.

We notice also some curiously hybrid names. "Parisiene Zone" leaves the reader puzzled to discover which language the

author intended to use and the English names of one or two species are confusing. For instance on pages 30 and 31 and elsewhere we find mention of pyreneean (printed pyrean) oak and white oak. Further on the pyreneean oak is referred to as the French *chêne blanc*, which leaves one uncertain whether the "white oak" is synonymous with the pyreneean oak or is to be referred to the American white oak (Quercus alba). Similarly is the term "occidental oak" any improvement on "cork oak" of which it is usually considered only to be a variety.

In view of the ever present possiblility of confusing American local names of species with English ones it would have been useful to extend the list of trees on page 407, which gives English and scientific names, to cover all the species referred to in the book.

A map showing the position of the chief forests referred to would have added considerably to the convenience of what is undoubtedly a most useful and interesting contribution to general forest literature in English.

MR. W. L. STRANGE'S NEW WORK ON IRRIGATION, ROADS AND BUILDINGS, AND WATER-SUPPLY OF TOWNS.

It was in April of the current year (1920) that Mr. W. L. Strange's work (of 830 pages) on the above subject was published.

Altogether some 500 copies or half the number of the first edition it is understood are out on the world, and this in eight months must be a record for so expensive (Rs. 45) a professional book. Mr. Strange is to be congratulated therefore on this satisfactory result of his labours. The demand for his book clearly indicates the degree of interest elicited, not only in India, but *in other parts of the world, in a work which deals solely with* Engineering problems.

While this is the case, however, my object in drawing attention to Mr. Strange's excellent work is to point out that it would be of practical use, not only to Engineers but also to Forest Officers in India, and Burma and the Malay Peninsula

and elsewhere. It is true that we have Mr. Rogers' work on Engineering in existence for the use of Forest Officers to guide us, a work which, in passing, I may mention I had the honour of reviewing and applauding in a leading Indian Journal some years ago, but such a great deal of up-to-date information and sound advice, based on scientific knowledge and personal observation, exists in Mr. Strange's new work that it is well fitted, it seems to me, for a place in the Official Library of the Forest Officer—not only in British India and Burma but also in Native States; and that Municipalities and Public Libraries would do well to obtain copies for their reference libraries as well.

More than ordinary interest attaches however from a public as well as an official stand-point to Mr. Strange's treatment of the subject of Irrigation which occupies 20 chapters or about two-thirds of the book—a subject which will appeal to Forest Officers, especially in Sind and the Punjab, and probably elsewhere where river protective works exist and where Canal irrigation is carried on. In Sind, for example, the cry of all Forest Officers has long been that there the P. W. D. by its embankment policy interferes with the efficient irrigation of their riverain forests—that is, cuts off the water-supply from them. Well, this cry has received some justification it is thought in the conclusions arrived at by Mr. Strange regarding the best method of harnessing an alluvial river.

After discussing the various issues at stake in regard to the best alignment to adopt for the control of alluvial streams, Mr. Strange concludes (*vide* pages 373—375 of his book), "The advantages of retirement (*i.e.*, of embankments) outweigh the disadvantages." A retirement of the bunds, as the earthen embankments are called in Sind, would, it may be mentioned, mean throwing open the old established and more valuable forests to the direct action of the river floods.

Emanating from such a high authority as Mr. Strange—who, it may be remarked, organized part of the South African system of Irrigation and also that of Ceylon, this opinion is well worthy of the attention of all the authorities concerned.

In Lower Sind, especially, the irrigation policy of the P. W. D. has been to try and hem in as closely as possible the lateral overflow of the Indus by embankments—which policy has of recent years led to somewhat disastrous results, if one may judge from the attention which has been drawn to this subject recently. Speaking at a Durbar at Tatta (*vide* "The Times of India" of the 5th February 1920), "The Commissioner in Sind, the Honourable Mr. P. R. Cadell, referred at some length to the disastrous floods in the Shahburwen District (of Lower Sind) owing to the Indus overflowing its banks and confidently hoped that the works undertaken by the P. W. D. would result in permanent improvement and greater security. The attention of Government and of the Public Works Department he said should necessarily be given in ensuing years to the great storage works in contemplation in Upper Sind, but it might well be hoped that a more scientific regulation of the river would result in more certain and more skilful irrigation......"

In view of this publicly expressed and weighty opinion on the present unsatisfactory state of things in Sind, the conclusion Mr. Strange has arrived at as to the general principles which should govern the control of the floods of an alluvial stream come at an opportune time and merit special attention.

More than a word of praise is due to the 220 very clear illustrations in the book, two-thirds of which are original and executed by the author himself.

The book has received unusually long and favourable reviews in the leading English professional journals, such as the "Times Engineering Supplement" July last (¾ col.), "The Engineer," for 29th October 1920 (3 cols.), and "Water Engineering," for July 1920 (4¼ cols.), and as these reviews differ from each other, in the selection of different parts for notice and commendation, it is abundantly evident that the book fills a want and that it appeals to a wide circle of readers.

G. M. RYAN.

## TREATMENT OF SEEDS.

*Presoak Method of Seed Treatment : A Means of Preventing Seed Injury Due to Chemical Disinfectants and of Increasing Germicidal Efficiency.*—By Harry Braun (Contribution from Bureau of Plant Industry) in the Journal of Agricultural Research, Vol. XIX, No. 8, Washington, July 15th, 1920.

The decreased and retarded germination of seed caused by the use of formalin, copper sulphate, and other germicides has hitherto militated against their use but the writers of the above paper have discovered a means of avoiding all the harmful effects and even of inducing in their stead an actual stimulation of germination. This result has been accomplished, the writers say, by a correlation of two fundamental principles of bacteriology and physico-chemistry : First, the established fact that micro organisms in an active vegetative condition or just resuming activity are more susceptible to destructive agents than when in a dry or dormant state ; second, the law governing the diffusion of dissolved substances whereby a solvent has a diluting effect on any solute diffusing into it from a stronger solution.

Numerous experiments were carried out with wheat and other cereals. Seeds counted out in sets of 100 were placed in loose cheesecloth bags and soaked thoroughly in the solution to be tested. The surplus liquid was then drained off, and the seeds were placed in covered moist chambers containing several layers of filter paper previously rinsed with the same solution. After definite periods of time the seeds were removed, spread out to dry overnight, and planted the next day in flats or pots in the green house. Untreated seeds were also planted as controls. Later in the course of the work treated seeds were planted outdoors at the Arlington Experimental Farm.

As a result of these experiments several facts stand out clearly. First, in all cases, with each variety of wheat, barley, oats, and maize tested, the presoak method minimized or eliminated the injury to seed germination due to the use of formalin and copper sulphate. Second, a marked stimulation of growth was

usually produced. Third, the presoak method proved fully efficient as a means of destroying or preventing the growth of the bacteria of the blackchaff disease borne on the seed and can undoubtedly be applied for the prevention of other diseases. Fourth, the method is simple and adapted to field conditions, since any farmer can apply it.

The author's summary of results is given in full—

(1) The use of formalin and copper sulphate as now practised usually causes retardation and injury to seed germination.

(2) Greenhouse and field experiments here reported have shown that this detrimental effect can be eliminated for standard varieties of wheat by allowing the seeds to absorb water for six hours before submitting them to the treatment with formalin or copper sulphate. Soaking for a short period (ten minutes) and covering for six hours, here designated the presoak method, is better than leaving in water for six hours. Similar results were obtained in experiments with barley, oats, and corn.

(3) The saturation of the seed cells and cell walls with water during the presoak period appears to be the factor counteracting the injurious effect on seed germination by diluting the disinfectant beyond the point of injury as it diffuses into the tissues and also by considerably decreasing the amount of water plus disinfectant solution which may enter the tissues after presoaking as compared to what may enter without any presoaking.

(4) Actual stimulation of germination has been observed repeatedly in presoak-treated seeds, a factor which by shortening germination minimizes the danger of exposure to the attack of soil organisms during this susceptible period.

(5) The bacterial blackchaff disease of wheat can be controlled without any injury to seed germination by a six-hour presoak of surface-infected seeds in water

followed by a six-hour treatment with formalin 1 to 400 in the manner prescribed.

(6) In practice, wheat seeds after being screened should be soaked with water for ten minutes at about six o'clock in the morning, drained, covered, and set away moist till noon, then soaked with formalin 1 to 400 for ten minutes, drained, covered, and set away moist till six o'clock in the evening, when they should be spread out to dry overnight to be ready for planting the next day.

(7) In planting, an allowance must always be made for the fact that there are fewer treated seeds in a bushel than there are of dry untreated ones. In general, it is recommended to sow about 25 per cent. more bulk than is usual of the dry grain, otherwise fewer seeds will be actually planted and the yield will be reduced correspondingly.

(8) The use of the presoak method tends to increase the efficiency of the disinfectant, in that the presoaking stimulates dormant bacteria and possibly fungi into vegetative activity, thereby rendering them extremely susceptible to the subsequent action of the disinfectant.

(9) The general use of the presoak method of treatment in farm practice for other diseases involves no radical change in present procedure, the only deviation being to keep the seeds moist for a definite period before giving them the disinfectant treatment.

(10) In applying the principles here utilized to other kinds of seeds, the determination of the lengths of the two parts of this method—(1) the presoak period, (2) the subsequent disinfectant treatment period—must be governed by the following factors: (*a*) the rate of absorption of water by the seeds, (*b*) the susceptibility of the seeds and pathogens to the disinfectant, and (*c*) the respective periods necessary for the beginning of seed germination and of vegetative activity of the

pathogen. In no case must the presoak period be continued until seed germination begins. The length of time necessary for the seeds to absorb about 30 per cent. of their weight of water is suggested as the length of the presoak period when not conflicting with the other factors involved.

(11) The presoak method of treatment, as here formulated, is proposed as a basis for the reinvestigation of practical seed treatment for all seed-transmitted diseases of economic importance amenable to control by formalin and copper sulphate as a means of eliminating seed injury and at the same time increasing germicidal efficiency.

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## RATE OF GROWTH OF CONIFERS IN THE BRITISH ISLES.

BULLETIN NO. 3, FORESTRY COMMISSION.

The first two chapters deal, in general terms, with the objects of the survey, the sample plot measurements and calculations, the method of quality class formation and the construction and application of the yield tables. Chapter III gives preliminary yield tables for certain exotic conifers. In Chapters IV to VIII the data are analysed with a view to investigating the effect of the various factors of the locality upon the growth of Larch, Scots Pine and Spruce, at first in general terms and then in rather more detail for each species in particular. In Chapter IX the evidence from the data as to the prevelance of canker in Larch, crown damage in Scots Pine and heart root in Larch, Scots Pine and Spruce is briefly discussed. Finally Appendix A gives yield tables for European Larch in the British Isles, Scots Pine in England, Scots Pine in Scotland, Norway Spruce in the British Isles and a table of Bark percentages ; Appendix B gives height quality class curves for the various species and Appendix C classifies the plots in various ways.

The details and reasons for the various methods used are not given though it is hoped to publish these at a future date. It will

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The details and reasons for the various methods used are not given though it is hoped to publish these at a future date. It will

be interesting to see this pamphlet when it appears, as we are a little surprised that the details were worked out by Hartig's method which is not more accurate than the volume curve method but very much more laborious both in the field and in office, gives a smaller choice in sample tree selection and above all necessitates partial calculations actually in the plot. The still more accurate form, factor, height, curve method would not be worth while employing for temporary plot measurements, which these apparently were, but the volume curve method is eminently suitable.

The general discussion of the effect of the factors of the locality will be read with interest by Indian Foresters and the writers conclude that soil is not sufficient to determine quality over a wide range of country but that exposure to the prevailing wind and elevation are more potent factors. Slope and aspect seem to have little influence on production. It appears that Larch and Spruce are tolerant in their soil demands whereas Scots Pine is more influenced by soil conditions, a conclusion which will perhaps surprise some. The bulletin brings out clearly the advantage of growing spruce at the higher elevations and also the large volume production of Silver fir.

The bulletin is interesting reading and the tables supply a long-felt want in Britain. Although the plots were taken over a wide and representative range of country, the figures seem to be all based on single measurements so that presumably a re-issue in a few years may modify them.

Two points are worth special reference. The method of forming quality classes is based on the height of the 50 year old tree and one quality class embraces a range of ten feet at this age. It is an excellent idea from the point of view of comparison between species and localities.

The other point is the question of the adoption of the quarter girth measurement in preference to true measure and taking the measurements by girth. The reasons given for its adoption are—

(1) the quarter girth is always used in practice in Britain ;

(2) the tape is the simplest method of measurement and requires less physical effort than the callipers ;

(3) as a result of tests the difference in the accuracy of the two methods of measurement, when carefully done, is negligible ;

and it is added that the quarter girth measure is just as absolute a unit as a cubic foot true measure.

We must join issue on all these reasons. So far as our experience goes the tape is not as simple a method of measurement as the calliper and, though it may require slightly more effort than the tape, the fact remains that every one who has tried both in the Indian hot weather prefers the calliper and, moreover, we have repeatedly tested the two methods and find that the callipers are 20 to 30 per cent. quicker than the tape. The statement that the comparative accuracy is the same is contrary to continental experience and contrary to our own. We have found in India that tape measurement gives an average result over four per cent. higher than the calliper, and it may be as much as over seven per cent. higher, which agrees remarkably closely with the continental results. It is true that quarter girth is an absolute unit of measurement, and its difference from the true measure is supposed to represent the wastage in squaring the timber. This wastage is a variable amount in itself and in any case does not help much as sawing wastage in conversion varies largely and still has to be known to calculate outturn, so why adopt a standard which represents nothing in particular? There is a movement against these odd standar America, in England and in India and all girth measurements are now excluded from Research work in India. We admit the force of the argument that quarter girth is generally used in Britain and for that reason quarter girth results can be *published* at first as well as the true volume, but at least the measurement should have been made by the correct method and if we can introduce the change in India, where the word "custom" is a far more potent factor than it is in Britain, surely it can be gradually introduced there. We think it unfortunate that the quarter girth system should have had this official recognition as it will only make the task of altering in the future more difficult.

# EXTRACTS.

## AIRPLANE PATROL OF THE FORESTS.

BY F. A. ELLIOTT, STATE FORESTER OF OREGON.

It may be safely said that the latest development in forestry is the use of airplanes in the patrol of Oregon's timber resources for the detection of forest fires.

Experiments along this line were carried on in Oregon last summer by the Air Service branch of the War Department, working in co-operation with the United States Forest Service and the Oregon State Board of Forestry. Last season's work may be classed as an experiment by the different services to determine the advisability of maintaining such a patrol from year to year. Would airplane patrol prove to be the more economic and effective, eventually replacing the patrol and look-out system now employed for forest fire detection and suppression? These and many other questions were in the minds of the men charged with the protection of Oregon's timber when the planes were first introduced. The Air Service had available planes and personnel at their disposal. These pilots, mechanics and planes must be kept in action, and the Air Service was anxious to determine the possibility of performing a real and valuable service in conjunction with their regulations, which provide that each pilot spend a certain amount of time in the air. The men on airplane patrol in Oregon last season are highly enthusiastic over the experiments and eager to become efficient in this new line of work, while the Forestry officials are extremely optimistic over the possibilities of organizing an efficient patrol system for the coming year.

Meetings of representatives from the Air Service, State, Federal and private forest protective organizations are being held and plans formulated for 1921. It is very probable that the War Department will give further assistance next season, and that a system of airplane patrol will cover Oregon, California Idaho

Montana and Washington. Such a patrol will disregard all State and National Forest boundaries and will conform to the general topography and character of the forest cover throughout the five States.

For Oregon alone, one complete observation squadron will be required to sustain a daily patrol of the 440,000 square miles of timber, brush and cut-over land which constitute a fire risk. This squadron will probably consist of 18 planes, most probably of the DeHaviland type, 180 men, from 30 to 40 officers, carrier pigeon lofts, and will include a photographic and radio section.

Besides maintaining a daily patrol during the fire season, it is planned to photograph the entire forested area. With the special aerial photographic appliances now in use by the Army, it is estimated by Army officials that this work may be accomplished in practically three weeks' time. Should the plan for the combined patrol of the five States be approved by the Air Service, primary control stations will be established at four places. The Oregon sub-bases will be located at Portland and eight other places. To accommodate the large DeHaviland ships, the landing fields must be at least 2,000 by 1,000 feet, free from obstructions such as trees, telephone lines, etc., and located on a level or fairly even slope of sod or firm soil. The advisability of going to any great expense in providing emergency landing fields along the patrol routes in the mountainous regions is not considered practical by the Air Service officials, since they state that such fields are apparently never located near where trouble occurs.

The mechanical success of the planes is beyond question when the following figures are considered regarding the distance covered by the Oregon patrol in 1919. The first patrol started in August 2nd, and continued until August 22nd, during which time seven Curtis type planes were used, four ships making two two-hour trips each day, flying at an average speed of 60 miles an hour and making a total distance of 20,160 miles during the 21 uninterrupted flying days. On August 23rd the Curtis planes were replaced by the larger DeHaviland type, as they can remain in the air nearly twice as long. This type was found to be the more

efficient and continued the patrol work until October 7th, when the fall of rains and cool nights made further patrol unnecessary for the season.

During the 35 actual patrol days by these five new ships two flying six hours each day at an average speed of 95 miles per hour, they covered a distance of 39,900 miles. The combined distance flown by the Curtis and DeHaviland planes during the 56 patrol days amounted to approximately 60,060 miles. This distance was traversed with only six forced landings; three due to inclement weather, and resulting in one wrecked plane. The other three were caused by motor trouble, resulting in the loss of one officer and the total loss of one ship. The entire operating expense was borne by the Air Service. The State and Federal Forest Service arranged the plan of patrol and gave the pilots and observers the benefit of their knowledge in fire detection and suppression gained through years of experience. They also provided landing fields, arranged for gasoline and guards for planes at sub-stations, provided transportation for the men to and from the fields, and co-operated with the Air Service in every possible way.

The area of effective visibility depends somewhat upon the atmospheric conditions and the altitude of the plane. At a height of 10,000 feet, under fair observation conditions, a very small fire may be easily picked up at a distance of 30 miles.

It is during smoky weather that the airplane patrol is much more advantageous than the look-out system. Neither smoke nor a difference of several thousand feet in altitude hinders the visibility as much as one would suspect. With the look-out system there is nearly always a section of the country back of the ridges which cannot be seen; with airplane all regions are equally visible. The airplane is not only effective for locating new fires, but, as the past season demonstrated, is extremely valuable in reporting progress on large fires or in exactly locating a group of series of small scattered ones. Experience has shown that a trained observer, after a reconnaissance from the air, can gain more useful information about the character of a large fire than can

a man on the ground in a heavily timbered area. Controlled fires can be covered each day to see that they do not break out anew.

At present it is not deemed advisable to reduce the regular patrol and look-out personnel; however, these men may be used more advantageously and, instead of being on patrol duty, may be bunched on improvement and construction work; each working crew to be provided with a telephone set and fire fighting equipment, so that upon report of a fire they may proceed without loss of time as an organized fire fighting crew.

The success of this new patrol depends principally upon the accuracy of the observer in locating the fire and the rapidity with which he reports the fire to the district ranger or warden in whose district the fire is located.

The accuracy with which a fire can be located depends upon the experience of the observer and the correctness of the maps with which he is provided. The State Forester has provided complete cover maps of Oregon, showing the timber lands, old burns, brush cut-over of farm lands and the location of all principal roads streams, cities and rail-roads.

Next season the Air Service officials plan to start the patrol at least one month before the beginning of the fire season in order that the pilots and observers may familiarize themselves with their duties and the country over which they will maintain the patrol.

The lapse of time between the discovery of a forest fire and the action taken for its suppression is a most decided factor in any fire-fighting plan.

Army planes equipped with wireless telephone sets will overcome this need of rapid communication. The United States Forest Service has been successfully experimenting with wireless telephones on Mount Hood and other look-out points. It is expected that by next season such progress will have been made in the experiments as to make their use practical. However, should it be found impossible to obtain the necessary wireless equipment, message-dropping from the planes can be successfully developed.

The observers may be regular Army men trained for this type of work, or they may be experienced fire-fighters employed by the Government or State; or at least such men will be often used in making a reconnaissance of large fires. Pilots and observers will carry food and fire-arms so that they may be provided for in case it becomes necessary to make a forced landing in an uninhabited region.

Carrier pigeons will also be used as a means of communication.—[*American Forestry*, Vol. 26, No. 316.]

## RELATION OF CONSERVATION TO TIMBER LAND VALUES.

No other industry furnishes the would-be reformer such material for his favourite pastime of " viewing with alarm " as he readily finds by a superficial survey of the lumbering activities of the United States. The bald statement that but 40 per cent of the industry's raw material is utilized is sufficient—to the uninitiated—to prove gross inefficiency and wilful waste. But the truth, when one really gets at it, is not nearly so bad as some frequently quoted generalizations would seem to indicate.

It is a business axiom that the reclamation of any waste product is practicable only when it is profitable. No business enterprise can afford to engage in conservation measures purely out of sentiment. The mountains of the West are full of minerals that would be tremendously valuable if it were possible to get them out and convert them to use without spending more in the operation than the value of the product. Every industry is compelled to " waste " those things which will not pay for their own conversion into useful commodities and in the lumber industry of the past, the percentage of such waste has run very high.

This situation, however, is changing rapidly. Chemical science has made important strides in the development of processes for the utilization of waste products of the forest ; and it happens that chemistry affords the chief key to the utilization problem in this industry. Then, too, the upward trend of timber

values in itself has tended to stimulate interest in every seeming opportunity to complete utilization. When the timber supply seemed inexhaustible, the attitude of those who owned timber was much like the attitude of the American farmer in the days when farm land was so cheap and it seemed more profitable to work the land out and move than to maintain its producing capacity by fertilization and rotation of crops. To-day timber has a value that serves as an incentive to the development of processes for its complete conversion into merchantable products, and this incentive is bound to increase with the unfailing advance in stumpage values.

A visit to the saw-mills of any section to-day will show that very few are wasting the short lengths and other odds and ends that every mill sent to the refuse burner a few years ago. As the standing grades of lumber have increased in value, these items have become saleable, and are adding to the profit of the business. But this is merely a first step in utilization. Other steps, of far greater importance, are being taken by lumber manufacturers in all parts of the United States, by way of installations of plants for the production of chemical by-products, paper pulp, etc.

It is not altogether improbable that the time may come when the by-product distillates of wood will rank in value with the product of the co-ordinate saw-mill operation. No one knows just when the production of petroleum may begin to fall below the tremendous and constantly increasing demand for oil. Whenever a serious shortage sends oil prices above a certain point, however, ethyl (grain) alcohol distilled from wood will afford an efficient substitute for many purposes for which oil products are now used, including the operation of internal combustion engines for the automobile and other automotive machinery. Grain alcohol may be produced from any wood at relatively low cost, and by a process which yields other products of value as well. Wood alcohol, produced by destructive distillation, is one of the pioneer by-products, but one for which the demand is increasing rapidly, but for direct use and to serve as a denaturing agent for grain alcohol distilled for industrial use.

Relatively few of the important chemical by-products can be produced from many different kinds of wood. Tanning extracts, for example, are obtained chiefly from the bark of oak and hemlock. Turpentine is reclaimed from these woods possessing the necessary resinous content. Pine oils, as the name implies, are produced from the pines. But chemical scrutiny demonstrates that practically every wood possesses important by-product possibilities that may be greatly magnified as experts explore further the field of organic chemistry.

During the war the range of by-products was greatly increased. In Germany, fabrics of many varieties were developed and manufactured from wood. Wood fabric rugs and carpets of serviceable character were produced. Bags and sacks, fibre silks, imitation leather and many other articles of utility found markets as substitutes for materials that were no longer obtainable. In the United States, too, recent years have seen remarkable development in the use of wood in manufacture of wall-board, an industry of great and growing size, and in the production of linoleums, heat insulating materials, etc., thus creating important industries that are totally dependent on our forests for their raw material.

Progress is dependent upon the chemist's pioneer work, plus commercial development and exploitation that create demand and find markets. Until these things began to be done, the lumber manufacturer necessarily limited his utilization to the conversion of his raw material into lumber and other primary products which he could make and sell with profit.

Much of this chemical pioneering has been done, but far more is coming and as it comes, it will steadily cut down the percentage of waste. Less of the tree will be left in the woods to rot. Less will be discarded as valueless at the mill. And a constantly increasing volume of other products than lumber will develop out of the saw-mill industry, with resulting increase in the profits of saw-mill operation and proportionate enhancement of the value of timber.

It is not unreasonable to suppose that eventually the value of chemical by-products may very nearly equal the value of direct

products of the saw-mill. In fact it has been estimated by competent engineers in connection with careful surveys of operating properties that in some instances the by-products possibilities of lumber enterprises now carrying on exceed in potential profit what the same operations are earning on their lumber.

These facts should be kept in mind in connection with the consideration of the merits of any timber property for which operating plans are now in contemplation. They have a direct bearing on future timber values and on the present earning possibilities underlying timber investments.—[*The Timberman*, Vol. XXI, No. 10.]

VOLUME XLVII NUMBER 5

# INDIAN FORESTER

*MAY, 1921.*

## THE IMPORTANCE OF TIMBER TESTS.

It is characteristic of human nature that where any commodity is plentiful little or no effort is made to use that commodity in an economical manner. Thus, in all timber-producing countries the custom has been to use wood lavishly and wastefully till scarcity arises. To-day, as a result, we are confronted by a world-wide scarcity of walnut, pine for structural purposes, oak and many other timbers, which heretofore have supplied material for special uses. Proper methods of afforestation will in time relieve this situation but meanwhile it is necessary to find substitutes. That this is possible cannot be doubted when we consider what has already been accomplished in Canada and in the United States.

In 1914 the Canadian Government opened, in conjunction with McGill University, the Forest Products Laboratories of Canada. These Laboratories, through their different branches, undertook to conduct research into the various methods of utilizing forest produce, and to devise efficient and economical methods of using as much as possible of the output of the forests. As an example of the kind of work they are doing, the work of the

division of Timber Tests may be cited. In 1914 this Division began a comprehensive study of the strength of all Canadian-grown timbers, carrying on its research in the Testing Laboratory of McGill University. Here were available the regular testing equipment of the University, and, in addition, two new machines installed by the Forest Products Laboratories. Representative trees from various stands in Canada were selected and shipped to the Laboratories, where they were sawn up under observations in the Laboratories' own saw-mill, and suitable small clear test pieces were prepared in an up-to-date wood-working shop. Tests were made of all the various functions of importance in the commercial utilization of the wood, *i.e.*, for bending, static, impact, compression, both parallel to, and at right angles to the grain; for hardness, shear, cleavage and tension. These tests were made on small clear specimens in order to eliminate the uncertain effects of knots, shakes, and other defects. In this way a reliable comparison of the various species was obtained, and data secured as to the effects of locality where grown, position of the wood in the tree, effects of seasoning, etc. These results, combined with the results of other tests made on structural sizes in commercial grades, furnish the most reliable guide as to what may be expected of the timber in use, and what provisions should be contained in grading rules.

The above may be termed routine work and is only one phase of the work of timber testing. Arrangements have to be made so that portions of the staff may, as occasion requires, be withdrawn from it to enable them to be engaged on special research work in order to obtain information on particular problems of special interest to different industries. A good example of this class of work was that carried out in Canada in testing mine timbers, which comprised making comparison of the species used, examining the properties of possible substitutes, determining the effects of different methods of seasoning, and the influence of defects commonly found in mine timbers, such as knots, shakes, and the like. To do so hundreds of tests were made on pit props, caps and booms on commercial sizes. These investigations showed among other things, that while Jack pine a species hitherto unused

in mining operations, would make rather inferior booms, it would, in point of strength, make excellent props.

Examples of this kind of work could be multiplied, but it is only necessary, at the present time, to indicate a few of the ways in which by carrying out timber tests, the results can be of the greatest use to wood-utilizing industries. Sometimes an enquiry may be answered at once from the results of former tests, but if not, a Testing Laboratory should always be ready to make new tests and establish new reliable information. In Canada they have dealt with such questions as : Are certain grading rules satisfactory for Douglas fir? Can red and black spruce be used in certain building construction where formerly hard pine was used, and if so what rules should govern their use? What woods are suitable as substitutes for oak and black walnut in the construction of telephone sets? Can Sitka spruce be used for tanks? What may be used instead of southern pine for implement poles? Is any other wood, so far as is now known, suitable for gun stocks instead of black walnut? Many similar examples might be quoted and we know that in India we have even a greater number of problems to solve.

The Forest Products Laboratories of Canada are not an experiment. For ten years their exact counterpart has existed in the United States, and yearly grown in importance and value to American industries. Australia and England are undertaking the same kind of work. Every great timber-producing country needs a means of developing the economical and efficient use of this valuable resource and there is no means so potent to this end as well-equipped and efficient Forest Laboratories.

Great as has been the advantage of laboratory research to the countries which have already employed it, to India with her hundreds of varieties of trees, many of which possess characteristics which render them peculiarly valuable, such work can be of even greater use. There can be no doubt that India has timbers suitable as substitutes for in any of the varieties now growing scarce. But the consumer does not yet know, as he must before he becomes a purchaser, what are the characteristics of the different woods.

In order to supply this information the Forest Research Institute at Dehra Dun is about to commence a study of the strength functions of Indian timbers. A testing plant similar to those used in Canada and in the United States has been procured and an expert, one of the original organizers of Timber Testing, in Canada, and until recently chief of the Divisions of Timber Tests in the Candian Laboratories, has been engaged as Officer-in-charge of Timber Testing for India.

It is hoped in the near future to be able to erect the testing machines, and to start this important branch of the work which is to be conducted in the interest of the Forest Department and the general public. Enquiries will be welcomed by the Forest Economist, from those who are interested in the production or the use of timber products, and it is hoped that full advantage will be taken of this by all to whom a knowledge of the relative strengths of the various Indian timbers is of value.

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## INDIAN TIMBERS.

*A paper read before the Indian Section of the Royal Society of Arts on January 21st, 1921. By R. S. Troup, M.A., C.I.E., Indian Forest Service, Professor of Forestry at the University of Oxford.*

Last July, two events took place in London the importance of which, from the point of view of the Empire's timber supplies, can hardly be overestimated: I allude to the British Empire Forestry Conference and the Empire Timber Exhibition, both of which served to focus attention on our existing timber resources and the steps necessary to ensure adequate provision for the future.

Many persons in this country are under the impression that teak is the only timber of importance produced by India; others more enlightened might add rosewood, and possibly also ebony

and satinwood, though Ceylon is a more important producer of the two last-named than India. Many visitors to the Indian section of the Exhibition, therefore, must have been somewhat surprised to see such a large number of different woods of whose existence they had had no previous idea, made up into panelling, high class furniture, parquet flooring, balustrades, and a large number of miscellaneous articles, including even golf clubs and fishing-rods. It may come as a further surprise to many that India can claim nearly, if not quite, 2,500 indigenous species of trees, of which oaks alone number nearly 40 species. Only a small proportion of these, it is true, rank at present as important timber trees, and of these only a portion can be placed in the category of trees yielding timbers likely to gain a footing on the markets of Europe; it is with these in particular that this paper will deal.

Before we proceed to consider some of the more important Indian timbers and their sources of supply, it would be as well to determine what classes of timber are suitable and available for export to this country, and what classes are not. It may be mentioned at the outset that durability, and in particular the capacity for resisting white-ants, is the deciding factor in the choice of the timbers, most widely used for constructional purposes in India, and woods which are not resistant to white-ants are relegated to a secondary position so far as extensive local consumption goes. Since the white-ant is happily unknown in this country, a number of very high-class woods, many with properties superior in some respects to those of timbers ranked as first-class in India, become available for export and are likely to be much more in demand in this country than they are in India, where the demand for timbers conspicuous for their beauty of colour and grain is limited. By common consent the three most important timbers of India are teak, sal, and deodar, all of which are resistant to white-ants. Teak finds a footing on the home market because of its unique properties, for as a ship-building timber it has no equal, and the keen demand for it has raised prices to such a level that it cannot be employed in India to the extent to which it would otherwise be used. Sal and deodar, abundant though they are, are in such

demand locally for railway sleepers and constructional work that they may be ruled out of account as important export timbers, and the same applies to certain other durable timbers of which the supply is not in excess of the local demand, and which can never be expected to command such high prices when exported as teak does.

A second important factor in the question of placing Indian timbers on the home market is that of comparative cost of freight. Recently sea freights have probably been higher than at any other time during the past hundred years, and in the early part of last year over £11 per 50 cubic feet was paid for freight from India. Freights have fallen since, and there is every hope that they will ultimately reach a reasonable level, for on this will depend to a considerable degree the possibility of developing a large export trade in Indian timber.

Recent figures show that freight charges from India to the United Kingdom are more than double those from Canada, and nearly double those from British Columbia, somewhat more than those from South America, but considerably less than those from Western Australia. This indicates what has actually been found to be the case in practice, namely, that whereas India can compete successfully with other countries as regards shipments of high-class timbers, she cannot compete with Scandinavia, Canada, and other countries in so far as coniferous and other timbers of the cheaper grades are concerned. This eliminates all idea of a successful export trade in Himalayan conifers, and in a large class of timbers which are without sufficient merit to command attention in this country, while it narrows down the choice to timbers suitable for high-class decorative or constructional work, furniture, and various other purposes demanding woods with special properties. Of these, however, it is doubtful if any part of the world can show as varied a selection as India can.

There are two other factors which cannot be ignored in connection with the development of an export trade in Indian timber; one is the distance of the forests from the sea-coast, and the other is the local demand. Generally speaking, the forests of the

Himalaya and sub-Himalayan tract, except possibly in Bengal and Assam, are so far from the coast that the long railway journey would render the cost of transport prohibitive, except in the case of specially valuable consignments, such as walnut burrs. As regards the local demand this increases as a rule with the industrial development of the country, in a province which is highly developed industrially, like the United Provinces, there is little or no timber to spare for export after local demands have been satisfied.

Taking the above factors into consideration, and omitting regions where for climatic or other reasons the forests produce little or no timber suitable for export, it may be said that those parts of the Indian Empire in which the development of an export trade in timber gives most promise are Burma, the Andaman Islands, the west coast of the Peninsula, and possibly to some extent Bengal and Assam. Burma promises the widest scope, but the forests of the Andamans also contain many high-class timbers, which will be available in considerable quantity at no distant date, since an extensive development scheme is now being pushed on. The total forest area of Burma is estimated at 130,000 square miles, of which, however, only 20,000 square miles have so far been constituted reserved forests, to be maintained permanently and managed systematically. On the basis of actual enumerations and assuming that there are 50,000 square miles of forest in Burma, where supplies of timber are such as to allow intensive working for trade purposes, Mr. Rodger, of the Indian Forest Service, has estimated that the quantity of timber, other than teak, standing in these forests and comprising trees three feet in girth and over, amounts to over 584 million tons, of which 110 million tons consists of *pyinkado* and 23 million tons of *in* (*eng*). Even allowing for all possible local demands and for the fact that a considerable proportion of this timber will be unsuitable for export, these figures indicate the great possibilities of Burma as an exporter of timber other than teak.

As regards the timbers themselves, time will not permit of a long recital of the numerous species which could be mentioned; a list of many of the more important Indian timbers will be found

in the catalogue of the recent timber exhibition, and apart from this there is a fairly extensive literature on the subject. I shall confine myself, therefore, to a few remarks on some of the timbers which attracted attention at the Exhibition and which hold out good prospects in so far as the development of an export trade is concerned. Teak, the premier ship-building timber of the world, and the bulwark of the Burma timber trade, is so well known that I shall pass it by in silence. Among the most abundant timbers of Burma is the *pyinkado* or ironwood (*Xylia dolabriformis*), reddish brown, extremely hard, strong, heavy and durable, and extensively used for railway sleepers and constructional work of all kinds; obtainable in large sizes, it would be much appreciated in this country for constructional work, and wherever great strength and durability are required: it finishes well, and makes admirable flooring. The *pyinkado* belongs to that great order of tropical timbers, the *Leguminosæ*, and to the same order belongs the rosewood (*Dalbergia latifolia*), a hard compact wood, of a purple colour with dark streaks; this wood is already well known in Europe, and is extensively used for pianoforte cases and furniture. It is shipped from the west coast of India, and before the war much of it found its way to Germany. Of other species of *Dalbergia* may be mentioned *D. Sissoo*, a brown, handsomely streaked furniture wood of Northern India: although this wood is fully utilized in the country, there may be a possibility of obtaining specially selected consignments from Calcutta. *Dalbergia cultrata* is a hard, compact, dark purple or nearly black wood, much resembling resewood, though not obtainable in such large sizes; there are considerable supplies in Burma. Of somewhat similar type, and belonging to the same great order, is *Millettia pendula*, also common in Burma: this dark chocolate-coloured wood is particularly handsome when made up into fancy articles and walking sticks, and is an excellent wood for parallel rulers and other mathematical instruments. *Padauk* is another leguminous timber. The true *padauk* (a Burmese name) is *Pterocarpus macrocarpus*, the Burma *padauk*, a brick-red to light-brown hard and very strong wood, which has been used for more

purposes than any other wood at the Madras gun-carriage factory; it is obtainable from Burma in somewhat limited quantity. For decorative work the Burma *padauk* is surpassed by the Andaman *padauk*, *Pterocarpus dalbergioides*, a hard, strong, rich red wood, often with dark streaks: this wood, which is exported from the Andamans, is already well known and appreciated for decorative work of all kinds, including panelling and parquet flooring, as well as for high-class furniture, including billiard tables. It has been used to some extent in America for the construction of Pullman cars. The last example of the order *Leguminosæ*, which we need consider, is *Albizzia Lebbek*, known in Burma and the Andamans as *kôkko*, sometimes termed East Indian walnut, and believed to be identical with a timber known on the American market as laurel-wood. It is a hard, dark brown wood, often beautifully streaked and mottled; at the recent exhibition it was admirably displayed in the form of a dining-room table, a suite of chairs in the Chippendale style, and other articles of furniture. It is better known in America than in this country where it deserves more attention. Future supplies will be available mainly from the Andamans, whence logs of considerable size are available. The woods of *Albizzia procera* and *A. odoratissima* are very similar to that of *A. Lebbek* and are probably mixed with it occasionally: they are available from many parts of India, and are common in Burma.

The dipterocarps, so called from their winged fruits, are members of a very important order of the Eastern tropics, and comprise such excellent timber trees as the *sal* (*Shorea robusta*) and the Burmese equivalents of the *sal*, namely, *thitya* (*Shorea obtusa*) and *ingyin* (*Pentacme suavis*); these are three timbers of great strength and durability, but the local demand for them is so great that it is doubtful if an extensive export trade in them could be developed. There are however two timbers belonging to this order which promise to have a great future in the markets of this country. One is the *gurjan* (*Dipterocarpus turbinatus* and other closely allied species), and the other the *in* or *eng* (*D. tuberculatus*). The former in particular is available in very large sizes:

the bulk of it comes from the Andamans, where large supplies are available, but there are considerable supplies in Burma where it goes by the name of *kanyin.* It is a light, reddish-brown wood, with a smooth, hard, even surface, and resisting grain, well suited for constructional work of all kinds, for flooring and for railway-carriage building. For the last-named purpose it is already making quite a reputation, and one of the leading railway companies has recently placed a large order for it: that company has tested it and found it stronger than English oak. At the timber exhibition, a room panelled entirely with this wood, finished without stain or polish of any kind, was most effective. Its suitability for plain wooden furniture was also well demonstrated by two bedsteads and by a garden table and chairs of a style usually made in teak at a much higher cost. *In* timber (*Dipterocarpus tuberculatus*) is very similar to *gurjan*, and is put to the same uses.

India possesses some good mahogany substitutes in *Pentace burmanica*, a beautiful, satiny, red wood, with ribbon-like markings, species of *Cedrela* (*e.g.*, *C. Toona* and *C. multijuga*), *Amoora*, and *Chickrassia tabularis.* All but the first-named belong to the same order (*Meliaceæ*) as Spanish mahogany. *Pentace* (Burmese *thitka*) is obtainable from Burma, and the others from Burma, Bengal, and Assam; *Cedrela* is also obtainable to some extent from the West Coast.

Among the various Indian species of *Terminalia* two deserve special mention, *T. tomentosa* and *T. bialata.* The former is a hard, greyish-brown wood, variable in shade, but often beautifully marked and streaked with darker brown, resembling European walnut, but with a finer figure and richer colour. Some exquisite furniture made of this wood was displayed at the exhibition, including a complete bed-room suite, a writing bureau, a vocalion, and a set of small drawing-room tables: a whole room was also panelled with it, and was most effective. This wood requires careful selection owing to its variability, and careful seasoning owing to its tendency to split in the process; the wood used in the exhibition was artificially seasoned, and gave no trouble. Plentiful supplies

of this timber are to be had from Burma and the West Coast. *Terminalia bialata* is a timber from the Andamans, of a silvery-grey colour, beautifully streaked with darker streaks. At the exhibition it was displayed under the name of silver greywood, in the form of panelling, parquet flooring, staircase and balustrade, furniture and miscellaneous articles: the wood was universally admired, and should have a great future before it. Like *T. tomentosa* it requires careful selection and seasoning. Another *Terminalia* of the Andamans is *T. Manii*, with a wood of fine quality, darker in colour than that of *T. bialata*.

Another wood which commanded attention at the exhibition, was *Adina cordifolia*, a bright yellow wood with a smooth, close, and even grain, which can be cut in any direction without splitting and is particularly suitable for carving; it is a valuable wood for the finer kinds of cabinet work, such as the making of chairs of the Empire style. Its admirable turning properties make it one of the best woods for bobbins, for which purpose it is employed in India. It is obtainable in large size and in fair quantity from Burma and the West Coast.

The most recent discovery in the way of carving wood is *Bursera serrata*, an even-grained, pinkish wood, obtainable in fair quantity from Burma. A handsome carved mirror frame of this wood was shown at the exhibition, and the carver stated that it was the best wood he had ever used. It is also very suitable for set-squares and other mathematical instruments.

Fishermen will be interested in the discovery of what may become a rival to greenheart. This is the product of a Burmese tree, *Heterophragma adenophyllum*, the wood of which resembles greenheart in appearance and properties. The wood is very tough and elastic, and is preferred to all others by the Burmans for making bows. It is never safe to prophesy how a wood will stand the test of time for an exacting purpose, like the manufacture of fishing-rods, but a rod shown at the exhibition had all the spring and elasticity of a greenheart rod, and the wood did not develop those fine cracks which condemn certain other strong elastic woods when put to such a delicate use. This wood is

worth a thorough trial. A very fair substitute for boxwood is to be found in the wood of certain species of *Gardenia*, which grow in the open forests of the Indian Peninsula. A consignment of this wood recently fetched a good price in London. At the exhibition it was used with good effect for inlay work and for various turned articles.

This brief account of a few Indian woods will have to suffice by way of example, though it includes only a comparatively small number of the more high-class woods available in commercial quantities, such as the various species of *Artocarpus*, *Lagerstrœmia*, *Hopea*, *Calophyllum*, *Michelia*, and others, and the remarkable variegated ebony known as Andaman marblewood (*Diospyros Kurzii*). The Indian timbers displayed at the recent exhibition are now to be seen at Messrs. Howard Bros.' premises, 4, Stanhope Street, and some of the exhibits of furniture are on view at Messrs. Waring and Gillow's establishment.

We may now proceed to the important question of establishing and developing markets for Indian timber in this country and elsewhere, but it will be necessary first to examine conditions as they have existed hitherto, and as we find them now. The State forests of British India are under the management of the Forest Department, which has charge of a total area of 251,000 square miles; each province has control of its own forests, and makes its own contracts, subject to a limited amount of supervision by the Government of India in important cases. Of what may be termed minor provinces with important forest areas, the Andamans and Coorg are under the direct control of the Government of India. Certain areas, at present aggregating 110,000 square miles, are set aside as reserved or protected forests, to be maintained and managed permanently as forest, so that regular supplies of timber are assured for the future. In certain cases the extraction and marketing of the timber is done by Government agency while in other cases, trees are sold standing and extracted by purchasers, or tracts of forest are leased for a series of years, the lessee undertaking the felling and extraction under a contract which imposes certain restrictions for the prevention of unauthorized felling,

Hitherto the teak trade of Burma has held such powerful sway that the comparatively limited export trade in other timbers has paled into insignificance beside it. Apart from a certain amount of extraction by Government agency, the working of teak in Burma is mainly in the hands of a few large firms, who hold purchase contracts. These firms have established themselves so firmly in the teak trade, and have done so well in it, that they have made little or no serious effort to develop an export trade in other timbers; this is not surprising, considering that teak is easily and cheaply extracted by floating, and is a timber with an assured market, whereas most of the other valuable timbers do not float, nor have they yet made their name in the markets of Europe. Progress in the past has undoubtedly been hampered by lack of facilities for the extraction of timber, in the shape of suitable systems of roads and other export work; this is particularly the case in Burma, where communications are notoriously backward. With the view to remedying matters the Government of India has recently started a new service of Forest Engineers, who will be specially trained in methods of timber extraction, and this should in time lead to improvements in this direction.

Efforts have been made by Government from time to time to induce timber firms, by the offer of liberal terms, to develop an export trade in timber other than teak, but the results have not been encouraging. I may mention in particular an offer made several years ago by the Burma Government of large quantities of *in* timber at very favourable rates for a limited period of time. It is perhaps fortunate that this offer was not accepted, because in introducing a new timber no useful purpose is served by placing on the market larger quantities than it can absorb: the proper course would be to introduce it in moderate quantities, with an assurance of larger and, above all, regular supplies in future. Past experience having shown the necessity for coming into closer touch with timber interests in the United Kingdom, if any success is to be achieved in the development of an export trade in Indian timbers, the Government of India recently appointed a well-known London firm as its agents for the sale of timber in Europe. It is

hoped that this appointment will lead to a wider use in this country of the many high-class woods which India produces.

A great deal remains to be done in the way of determining the best methods of seasoning the various timbers; several of those sent home for the exhibition were seasoned artificially in London with complete success, and there is little doubt that artificial seasoning will play a prominent part in the future utilization of Indian timbers. The importance of careful seasoning is not always fully recognized, otherwise there would be fewer complaints regarding the behaviour of timber when utilized; in introducing new woods on the market this is a matter of special importance, since first impressions count for a good deal, and a bad reputation once acquired, however undeservedly, is difficult to eradicate.

But one of the most important of all considerations is the careful selection on the spot of consignments to be exported, if necessary, after conversion into planks or other assortments; this indicates the necessity for employing competent agents for this work, men who are in close touch with the requirements of the home market, and who also have a thorough training in the technical part of their work. For however well an undertaking may be financed and managed from home, ultimate success must depend very largely on the capacity of the local manager. I cannot help feeling that a good deal more might be done in the way of developing the technical side of timber work, particularly in its application to countries like India, where new timbers have to be sought for and brought on the market. A prudent mining company does not work its mines without the aid of trained mining engineers, nor are chemical works established and carried on without trained chemists. Yet timber companies employ assistants without any previous training in the technical side of their work, including some knowledge of the growth of trees and the structure, properties, and identification of timber.

Until such trained men are employed, there is not likely to be any rapid advance in the somewhat difficult work of establishing markets for new timbers. At present the question of establishing a first-class forestry training centre for the Empire

is under consideration. Such an institution should be in a position to turn out men with a preliminary technical training in timber work. If the demand for such men arises, then the supply should follow as a matter of course, and the training could be adapted to meet different requirements. I would commend this question to the notice of those in the timber trade with reference not only to India but also to other parts of the Empire.

While we have here dealt mainly with the development of an export trade in Indian timbers we cannot ignore the great possibilities of creating new wood-using industries within the country. The antiseptic treatment of timbers on a large scale should bring into use for railway sleepers and constructional purposes a large quantity of timber which is not sufficiently durable if used untreated. But for the war, and the difficulty of obtaining creosote, more progress would have been made in this direction. A good deal has been said in recent times regarding the industrial development of India, and in this development timber-using industries should play an important part. A large wood-working institute has recently been established by the United Provinces Government near Bareilly, in the United Provinces, and this institute is beginning to demonstrate the practicability of employing Indian woods for purposes for which foreign woods have hitherto been used. Attached to the institute is a bobbin factory, which is turning out excellent bobbins, packing arms, spools and other articles. When the local bobbin industry becomes more firmly established, it is probable that India will cease to import beech-wood for the purpose, as she does at present. Among other important wood-using industries now being started in India is that of the manufacture of ply-wood. An enterprising firm has established a plywood factory in Assam, primarily for the manufacture of tea-boxes. There is room for considerable development in this direction, since the forests of India produce abundant supplies of timber well suited for the purpose, and there is no reason why India should import tea-shooks in quantity from Japan and elsewhere, as she has done in the past: on the contrary with the possession of so many suitable woods, among which may

be included the maples of the Himalaya, India should in time become an exporter of plywood.

I shall conclude this paper with a brief account of the part which Indian timbers played during the war. The figures available refer only to the period from April 1917 to October 1918, that is a period of about 18 months, during which timber supplies were in the hands of the Indian Munitions Board. The overseas destinations were Mesopotamia, Egypt, and Salonika, and to a more limited extent Aden, East Africa, the Persian Gulf and other places. The total quantity of timber shipped to these destinations amounted to 198,000 tons, while in addition 30,000 tons were consumed for war purposes in India, making a total of 228,000 tons, or an average of about 12,600 tons a month. These figures include bamboos, but they do not include railway sleepers for over 1,800 miles of track. Supplies were maintained by the establishment of large timber depôts at Bombay, Karachi, and Rangoon, which were kept stocked, with various assortments likely to be in demand, so that indents could be met as soon after receipt as possible. Successful efforts were made to substitute Indian for foreign timber in order to reduce the demands on shipping, and to encourage the use of Indian timbers. It is interesting to note, however, that for the manufacture of rifle-stocks no other Indian timber has yet been found equal to walnut: during the last few years numbers of rifle-stocks have been made of Himalayan walnut, which is the same as the European species, *Juglans regia*. Efforts were made during the war to find timbers suitable for aircraft construction. Of the woods tested, Andaman *padauk* was found suitable for propellers, and also as a substitute for ash for longerons, provided it is used where it does not require to be steamed and bent: a species of *Albizzia* (possibly *A. odoratissima* or *A. procera*), and rosewood (a sample grown in Java, and probably *Dalbergia latifolia*) were also pronounced suitable for propellers.

In conclusion, I hope that in the brief space of time at my disposal, I have been able to indicate in some slight degree the future possibilities in the way of utilizing Indian timbers

provided their exploitation and marketing are carried out intelligently.

[An excellent series of lantern views was shown and described by Professor Troup. The discussion which took place on the paper will be given next month.—HON. ED.]

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## NOTES ON AN ATTACK OF *PYRAUSTA MACHŒRALIS* ON TEAK IN ZIGON AND THARRAWADDY DIVISIONS IN 1920.

The following notes are very incomplete, as the initial stages being unexpected were not carefully observed, but a few interesting points were noticed in the later stages, which as far as I know have not before been observed.

It is probable that the attack started in the early part of the rains, but it was not obvious till mid-August, three months after the rains began. At that time several mature teak trees as well as plantations 20 to 35 years old were noticed in the neighbourhood of Kunsan to be heavily attacked. Foliage was becoming thin, and the noise made by the droppings of the caterpillars on the undergrowth was very noticeable.

Later on, on the 15th September, the writer was touring in Tharrawaddy Division, some 30 miles further south, and found a similar attack in progress, both on mature and young teak, the foliage having attained the characteristic rusty appearance, and the ground in plantations being already carpeted with fallen leaves and the canopy noticeably thinned by their premature fall.

Here the fallen leaves were found to be full both of live and empty pupæ, and the undergrowth swarming with the emerged moths.

Both here and at Kunsan large numbers of crows (*C. macrorhynchus*) had collected and were busy eating the larvæ on trees which were not already bared of foliage.

But, what was more serious, a young regeneration area was seen on which teak saplings had not only lost their foliage, but the leading shoots showed signs of dying off from the top downwards.

The writer was not on tour again till early in November. By that date at Kunsan and on other heavily infected areas the

leaf-fall was complete and trees looked exactly as they do in May, a new flush of bright green leaves having grown.

This was found to be the case in young plantations also, one of 1917 being found with nearly all its leading shoots dead.

A plantation of 1918 about 15 miles to the south was then visited, and the fear of this type of damage amply confirmed. The saplings, varying from 10 to 20 feet in height, showed a brilliant new crop of leaves, but in hardly a single one did this crop extend above the third node below the leading bud. The shoots of the year, which had grown several feet during the first half of the rains, had dropped their leaves, and new green leaf-bearing branches were growing from their axils up to a certain point, but the upper portions had completely died off and become hard and dry. There was no damage by boring insects or any other cause, and the harm was directly due to defoliation. The leading bud, which in teak is the only active bud on the year's shoot, had been deprived of the nourishment afforded by the leaves immediately below it, and, its rudimentary leaves being unable yet to carry on transpiration, gave it up and succumbed. Desiccation extended downwards for two, three and sometimes four nodes, before the highest axillary branches appeared, and these branches became progressively longer and more vigorous further down the shoot.

The appearance of the plantation at a distance was peculiar, its brilliantly fresh foliage being topped with a forest of black leafless sticks.

It would be interesting to see whether a sapling would die off similarly if its leaves were pulled off by hand during the period of active transpiration.

There is of course no alternative in such a case to coppicing the whole plantation and trusting to freedom from the insect next season, aided perhaps by a thorough burning. The subsequent growth of such damaged saplings not coppiced would be too awful to contemplate.

The general belief used to be that this insect does no real damage to teak trees.

It has been suggested lately, I believe, that defoliation of older trees results in a growth of epicormic branches. This is quite possible, but is not noticeable in the present case; no fresh epicormic branches have been put forth. The new growth seems to be carried on by subsidiary leaders on branches, which continue their elongation as before the check, or by axillary buds along shoots whose elongation is less and whose internodes are shorter than on the main leader.

It is clear, however, that a particularly severe attack on saplings at the stage when elongation of the main shoot is the principal activity, is indeed harmful, and as this stage continues practically till height growth gives way to crown-enlargement and flowering begins, *viz.*, up to 10 to 15 years, the loss of increment may become really serious, not to mention the expense of coppicing and subsequent tending of coppice-stems.

If at all frequent, attacks of this severity will affect our teak-planting policy even more than the 'beehole borer,' which after all seldom goes further than damaging the appearance of teak timber after conversion.

This, then, is by far the most serious result to expect from this insect's ravages. Whether the same has been noticed in cases of *Hyblæa* elsewhere is not known to the writer.

The question also arises whether the girth increment of defoliated trees is affected or not, this could be ascertained by accurate girth measurements during a season of attack, or, when records of past attacks are available, by reference to the relative breadth of annual rings ascertained from stump countings or Pressler's borings.

The few observations made on the ring put on during the growing season of 1920 by defoliated trees show no marked check to growth: this is probably due to the fact that the bulk of the annual girth increment is put on in the early part of the season.

For this reason, and also because in a severe attack the new flush of leaves may stimulate renewed growth late in the season, it is quite possible that girth increment is not decreased. In fact—

'its an ill wind..... ...' —and perhaps the severer the attack the broader the ring put on ! A moderate attack leaves the skeletonised and functionless leaves on the tree, a severe one substitutes a new flush and with it renewed activity.

As a repressive measure, the application of the feet of Government elephants has, I believe, been tried ! Mr. Stebbing says that in the Central Provinces the larvæ hibernate in the soil, and if they do, perhaps elephants might chance to make things unpleasant for a few of them by their heavy tread.

But this is hardly a practicable suggestion for large areas, and enquiry should be made into nature's repressive measures with a view to their possible amplification or encouragement.

The writer, after seeing the swarms of pupæ in fallen leaves in September, was hopeful that fire might be employed effectively later on.

But unfortunately the resulting brood of moths do not seem to have continued the plague, and the leaves now (January 1921) on the ground contain no live pupæ whatever, nor are there any larvæ now feeding. Whether the pest has starved itself by having eaten up its own food, or whether some other influence has exterminated the moths or larvæ, or whether the larvæ are hibernating, is the question. In the badly attacked areas, before the new leaves flushed there was certainly no food left. Nor has the new flush been appreciably devoured. And there was certainly a suspicious number of pupæ of parasitic flies in evidence among the Pyrausta cocoons. And careful searching in the surface soil has failed to disclose a single hibernating larvæ or pupæ. This rather sketchy evidence suggests that the last brood came to a bad end somehow.

But such are the ways of nature that this may be quite the normal thing, that vast numbers of lives should be sacrificed after their work is finished for the season, to be renewed after the lapse of months through the fortuitous survival of a few individuals.

It is the local belief in these parts that years of scanty early rains are years of severe defoliation. Probably it is quite true that a bout of really wet weather just after the emergence of

larvæ on the leaves would drown them in large numbers. But in absence of careful observation there is no real evidence for this. The matter needs research and much more detailed records than are available for the past season. Inquiry of the local people is unreliable: this year some say that such attacks occur annually, others that they never remember so bad a case. There is, however, no sign of the leading shoots of young teak ever having been killed out in this way before.

Fire-protection also affords no clue. In the past season the fire-protected area shows up no worse than that not protected. One fact is, however, very evident, that in localities where pure teak plantations are numerous the attack is always more severe, spreading even to scattered trees outside plantations, than in ordinary mixed forest remote from them.

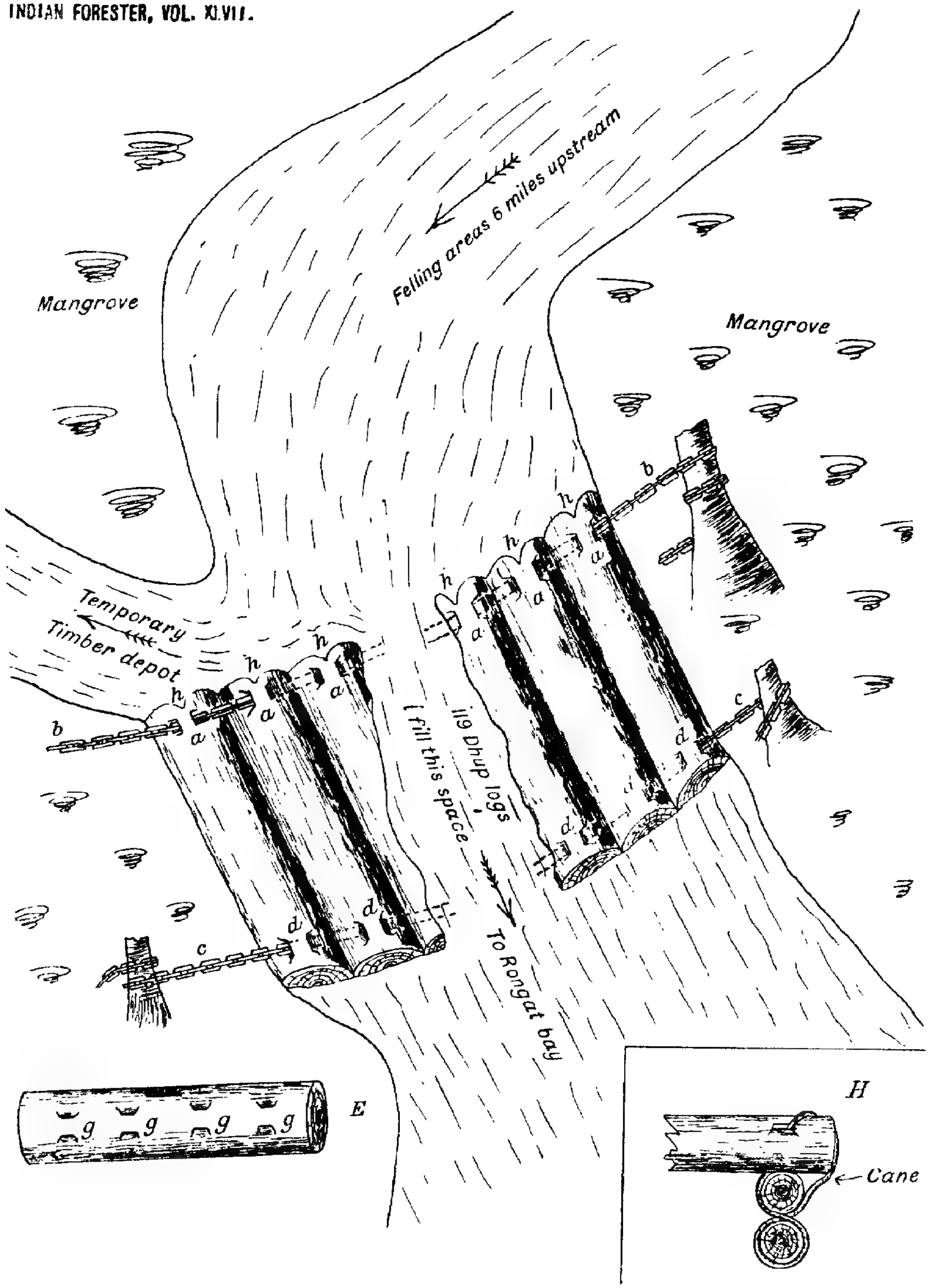
C. G. E. DAWKINS,
*D. C., Forests.*

THARRAWADDY:
*February* 1921.

## THE RONGAT BOOM.

The Rongat boom was first put up in 1918, the idea, a departure from the usual type, being that of Mr. M. C. C. Bonington, now Divisional Forest Officer, North Andamans. The strong under-current running in the Rongat stream, a tidal creek, had a tendency to suck down logs, which, striking against the ordinary type of boom, escaped underneath and unless a very strict supervision was kept, were lost in the open sea. As supervision was exceptionally arduous when floods occurred at night and even contained an element of danger, the need for a more substantial barrage was felt.

A spot was selected a short distance below a bend in the Rongat stream so as to break the force of drifting logs and a tributary streamlet running westward at this point served as a convenient depôt where logs could be quickly stored to obviate the danger of a jam. The stream was about 170 feet wide and 30 feet deep at this point and immediately widened out into the Rongat Bay.



Felling areas 6 miles upstream
Mangrove
Mangrove
Temporary Timber depot
h
h
h
h
h
h
h
a
a
a
a
a
a
b
b
c
c
d
d
d
d
( fill this space
119 Dhup logs
To Rongat bay
g
g
g
g
E
H
Cane


No. 1600

The boom was constructed of *dhup* (*Canarium euphyllum*), a timber of great buoyancy, the method being as follows:—

One hundred and twenty-five *dhup* logs 25 feet long and 8 feet in girth were felled and *napa* holes (*a*) cut on the fore-end of each. A heavy 3 inch chain (*b*) was then passed through and attached to the mangrove on either bank, but a littler higher up on the right bank as in the sketch. A lighter chain (*c*) was similarly run through *napa* holes (*d*) on the after end of each log and secured. Drifting logs on a flood-tide are, owing to the bend in the stream, diverted towards the left side of the boom where the pressure in a rush is very great. In order, therefore, to prevent timber escaping under the boom at this end, four logs of *gurjan* (*Dipterocarpus turbinatus*), a very heavy wood, 25 feet long and 8 feet in girth were felled (section E). Four *napa* holes (*g*) were then cut in each log and two of these logs lashed lengthways with cane underneath the fore-end of the boom and starting from the left as it was only necessary to safeguard this side. The two remaining *gurjan* were then lashed underneath those again, so that, for a distance of 50 feet from the left side of the boom, there were two lashings of *gurjan* logs, one next the other (section H). In the original boom eight *gurjan* logs were thus secured, but the writer, when he re-erected the boom the following year, found four quite sufficient. The first underneath row was lashed with split canes, passing through the *napa* holes of the *gurjan* so as to embrace the major circumference and then over the fore-end of the boom and round the chain, the canes resting in deep V-shaped notches (*h*) cut into the *dhup*. The second row was lashed round the first. The whole structure on a flood-tide presented the aspect shown in the sketch except that there was a small space between the *dhup* logs to lessen the pressure against the boom in a flood. Similarly a small space was left between the first row of *gurjan* and the *dhup* and between the second and first rows of *gurjan*, and the boom could be tautened or slackened according to the strength of the flood.

The Rongat boom is usually erected early in June so as to be ready for the South-West monsoon floods. Timber is collected

on the banks of the creeks six miles further upstream and thrown in when the monsoon breaks. The logs, coming down on a flood, strike the boom obliquely and shoot into the branch stream on the left where they are rafted and kept ready. When the flood abates the left end chains are slackened to allow of the raft passing through and the latter is then taken to the "Rosamond," loaded and taken to Port Blair. The boom is working throughout the months of July, August and part of September. It is then dismantled and the timber shipped to Port Blair. The average number of logs and squares brought down on floods during the South-West monsoon is 3,000 and the writer last year in two floods collected 750 logs. The initial heavy downpours last generally two and a half months and thereafter floods are spasmodic. Timber is then built into rafts at the spot where it is thrown into the creek and brought down by timber boat, the journey down taking two days.

The upkeep of the boom is comparatively small. If flotsam brought down by the tides is cleared every day there only remains the renewal of cane lashings about once a week. A hut is built on the boom and a file of ten men live there throughout the floating operations. This boom is erected in 20 days with a file of 20 men and the assistance of a steam cutter. With convict labour the approximate cost is :—

| | | |
|---|---|---|
| 20 men for 20 days at 6½ as. per man per day | Rs. | 165 |
| Steam launch crew for 20 days ... ... | „ | 95 |
| Total cost ... | Rs. | 260 |

Free labour is now gradually displacing convict labour in the Middle Andamans and the cost of erection is greatly enhanced. But even so the immense saving in time and labour more than justifies the re-erection of the Rongat boom during floating operations.

J. Boreham, E.O.

## FOREST STUDENTS IN TRAINING.

From the report of delegates for Forestry we gather that the number of students who attended the course of instruction in Forestry at Oxford during 1920 was as follows:—

| | | At the commencement of the year. | At the end of the year. |
|---|---|---|---|
| First year students | ... | 80 | 28 |
| Second year students | ... | 38 | 66 |
| Third year students | ... | ... | 6 |
| Total | ... | 118 | 100 |

Of the 80 first year students at the beginning of the year five completed the diploma course, two completed special course, one died, and six withdrew from the course, leaving 66 as second year students at the end of the year.

Of the 38 second year students at the beginning of the year, 30 completed the diploma course, four have not yet completed the course and four withdrew.

It is not known how many of these are probationers for the Indian Forest Service.

At present there are at Edinburgh 16 Indian Forestry, 9 Colonial Office and 10 South African probationers—a total of 35.

The number of probationerships for the Indian Forest Service offered in July last was over 60 and we believe that not more than 25 were eventually selected. Considering that the existing cadre of imperial officers exceeds four hundred and that the present effective strength is below two hundred, it will obviously take time to fill vacancies. Meanwhile the department will be much retarded in its development unless other means of helping to carry on can be devised.

## THE EXPORT OF INDIAN TIMBERS.

Statement showing the quantity and value of Teak wood and other timber of Indian merchandise exported abroad by sea from British India (excluding Burma) and Burma during the official year 1919-1920:—

| Teak wood. | British India (excluding Burma) Quantity Cubic Tons | Value. | Burma. Quantity Cubic Tons. | Burma. Value. |
|---|---|---|---|---|
| | | Rs. | | Rs. |
| United Kingdom ... ... | 554 | 1,15,785 | 41,921 | 96,79,415 |
| Aden and Dependencies ... | 9 | 4,460 | ... | ... |
| Bahrein Islands ... .. | 372 | 40,342 | ... | .. |
| Maldives ... ... | 25 | 5,961 | ... | ... |
| Ceylon ... ... ... | 103 | 28,247 | 527 | 79,065 |
| Straits Settlements ... ... | ... | ... | 49 | 7,376 |
| Egypt ... ... ... | ... | ... | 284 | 1,22,120 |
| Cape Colony ... ... | 7 | 1,947 | 1,723 | 5,40,749 |
| Natal ... ... ... | ... | ... | 2,225 | 7,92,573 |
| Transvaal ... ... | ... | ... | 166 | 61,410 |
| Mauritius and Dependencies ... | ... | ... | 288 | 28,798 |
| Zanzibar and Pemba .. | 1 | 440 | 65 | 7,500 |
| East Africa Protectorate ... | 154 | 46,606 | 100 | 21,500 |
| Australian Commonwealth ... | 10 | 7,847 | 240 | 56,881 |
| Sweden ... ... | 117 | 34,149 | ... | ... |
| Holland ... ... | ... | ... | 85 | 25,582 |
| Maskat Territory ... ... | 18 | 2,150 | ... | ... |
| Other Native States in Arabia ... | 324 | 19,972 | ... | ... |
| Turkey Asiatic ... ... | 144 | 23,735 | 325 | 38,981 |
| Persia ... ... ... | 72 | 27,382 | ... | ... |
| Philippines ... ... | ... | ... | 1,301 | 2,45,895 |

| Teak wood—(*contd.*) | | British India (excluding Burma). Quantity Cubic Tons. | Value. | Burma. Quantity Cubic Tons. | Burma. Value. |
|---|---|---|---|---|---|
| | | | Rs. | | Rs. |
| Portuguese East Africa | ... | ... | ... | 220 | 62,769 |
| United States of America | ... | ... | ... | 1,153 | 4,11,380 |
| Chile ... ... | ... | ... | ... | 19 | 2,280 |
| Other Foreign countries | ... | 7 | 2,275 | 2 | 500 |
| Total | ... | 1,917 | 3,61,298 | 50,693 | 1,21,84,774 |
| Other timbers. | | | | | |
| | | | Rs | | Rs. |
| United Kingdom ... | ... | 489 | 61,110 | 147 | 26,393 |
| Aden and Dependencies | ... | 205 | 17,405 | ... | ... |
| Bahrein Islands ... | ... | 517 | 28,865 | ... | ... |
| Ceylon ... ... | ... | 104 | 14,557 | ... | ... |
| Egypt ... ... | ... | 21 | 6,300 | ... | 27 |
| Cape Colony ... | ... | ... | ... | 99 | 10,856 |
| Natal ... ... | ... | ... | .. | 31 | 4,471 |
| East African Protectorate | ... | 9 | 1,775 | ... | ... |
| Belgium ... | ... | 14 | 840 | ... | ... |
| Turkey Asiatic ... | .. | 2,953 | 2,56,259 | 7 | 903 |
| Maskat Territory ... | ... | 345 | 21,634 | ... | ... |
| Other Native States | ... | 1,551 | 88,011 | ... | ... |
| Persia ... ... | ... | 395 | 30,062 | ... | ... |
| Other ... ... | ... | 14 | 1,312 | 1 | 145 |
| Total | ... | 6,617 | 5,37,130 | 285 | 42,795 |

[*Department of Statistics, India.*]

# EXTRACTS.

## THE EFFECTS OF FOREST REGENERATION.

The Effects of Forest Regeneration, especially of Pines, on Soil Nitrification, Researches in Sweden.—Hesselmann, H., in the Meddelanden frán Statens Skogsförsöksanstalt, Part 13-14, pp. 923-1076+48. Stockholm, 1917.

In the greatly discussed problem of the regeneration of forests, the part that has been least studied, although it may possibly be the most important, is that of the physiology of regeneration for which the three factors of climate, provision of light, and nature of the soil must be taken into account.

The soil should be considered from two points of view: (1) its greater or less power of favouring germination; (2) its capacity for supplying plants with the nutritive principles they need during the first year of their growth. These two qualities are not necessarily found united in the same soil. The author particularly considers the second, in relation to normal forest-management, and, for theoretical and practical reasons, he first deals with the question of the nitrogen of forest soils.

Little or even no nitrification takes place in the mossy soils of the Swedish pine forests; the organic nitrogen does not pass beyond the ammoniacal stage even in the most productive of the mixed pine forests. Clearings that admit much light have a marked influence on the transformation of the nitrogen; in those places where the layer of humus, composed of moss and dead needles is rather thin and loose, clearing may lead to the nitrification of the humic nitrogen, because it produces a radical change in the bacterial flora of the layer of humus; but when the layer is compact all that apparently happens is a more active transformation of the nitrogen of the humus, which does not, however, reach the stage of nitrification.

The successive changes taking place in the layer of humus can be determined, up to a certain point, according to the soil flora: where the soil nitrogen is undergoing nitrification nitrophilous plants appear, such as the raspberry *(Rubus Idaeus)*, Rose-bay (*Epilobium angustifolium)*, sandwort (*Arenaria trinervia*) *Galeopsis bifida*, *Senecio sylvaticus*, sheepsorrel (*Rumex Acetosella*), etc.; where the layer, on the contrary, is being transformed into mould, without nitrification of the humic nitrogen, the characteristic plant of clearings, *Aira flexuosa* (wavy hair-grass) predominates.

A careful way of preparing the soil consists in mixing the covering of humus with the mineral soil, and if dead wood and twigs are buried it favours nitrification, even in the case of quite compact covering. Paring and burning has the same effect.

There is a close parallelism between the nitrification of the humic nitrogen and the possibilities of regeneration. Forests where even ordinary thinnings bring about nitrification are regenerated fairly easily; similarly road-side slopes, places where stumps have been chopped and burnt, are often characterised by nitrification of the humic nitrogen and by fine regeneration; again fallen trunks and twigs favour nitrification and consequently regeneration. On the contrary, however, regeneration is difficult in soils of compact humus where there is no nitrification. Both from the results of experiments and from direct observation of nature, it would seem that the young Scotch fir *(Pinus sylvestris)*

grows more vigorously in soils having a humus layer in which nitrification takes place than in the opposite case, and the same is probably true for the spruce also. In spruce forest with a grassy ground, nitrification usually goes on in the soil and increases after cutting, which may sometimes result in an under-growth injurious to the spruce; these trees, it is true, do not favour the growth of vegetation in the underwood owing to their tendency to form compact little groups, but, all the same, it is often important to limit the vegetation in the glades, so as to lessen a competition that might be fatal to the wild trees.

The conclusion is that, for operations relating to regeneration, it is necessary to be guided according to the mode of transformation of the humic nitrogen in forest soils.—[*International Review of the Science and Practice of Agriculture*, Year X, No. 4, April 1919.]

VOLUME XLVII NUMBER 6

# INDIAN FORESTER

*JUNE, 1921.*

## THE COMMERCIAL CONCENTRATION OF REGENERATION OPERATIONS IN THE PUNJAB HIMALAYAS.

It is some eight years since the attention of Punjab forest officers became directed to the advisability of concentrating regeneration operations in the hill coniferous forests for sylvicultural reasons. At that time the selection system with its various modifications was in force in all the hill forests, and it had been found that the scattered nature of the fellings under this system rendered it impossible to pay that continuous attention to the regeneration of the forests which is necessary in order to insure successful results. All recent Working Plans have had as their basis the concentration of the regeneration operations and the advantages of the change in system are now universally recognised.

Those who advocated the change eight years ago were content to base their arguments on sylviculture; they did not consider the matter from the point of view of economic timber extraction and had no idea of interfering with the time-honoured dependence of Indian forest officers on natural regeneration.

Recent developments, however, seem to indicate that we shall be obliged for commercial reasons to concentrate our regeneration operations to a greater extent than was ever contemplated, and as a natural corollary abandon our dependence on natural regeneration.

The war has increased the demand for the less valuable fir, spruce and pine timbers which cannot pay high costs of extraction, and has shown the necessity for improving our extraction methods. Attempts to supply the North-Western Railway with fir and spruce sleepers by the old methods of sawing the sleepers in the forest and hand carriage to the river have, in some of the forests of Bashahr Division, resulted in a loss of eight annas on every sleeper supplied.

Before proposing alterations in our present systems of extraction it is advisable to consider the principles governing the economic extraction of timber and the reasons for the existing methods practised in India.

The most economic manner in which to carry timber—or any other produce for that matter—is to do so in bulk, that is in logs of the largest possible dimensions. Apart from cheaper transport, logging has a great economic advantage over scantling work in that the enormous loss of material resulting from the latter is saved as pointed out in the August 1920 issue of the *Indian Forester* in an article entitled "Waste in Timber Exploitation" by Mr. E. A. Greswell. For the extraction of such logs, however, transport ways, either water, road, rail, or wire, capable of dealing with large volumes and weights are necessary. In Europe such ways in the form of railways and roads usually exist in close proximity to the forests and are permanently maintained for general purposes, so that timber has the use of them at very small expense, *the quantity of timber extracted not affecting the charge per c.ft.* Thus the European forest officer has never been under any necessity of subordinating his sylvicultural systems to economic extraction.

In the Punjab hill forests the case is different: such ways, except in the form of floatable rivers—usually at a considerable

distance from the forests—are non-existent; if the forest officer requiries them he must build them himself and his timber must bear the whole cost, so that *the cost per c.ft. will be in inverse proportion to the quantity extracted.*

Such projects may be either of a permanent or temporary nature. To the former class will belong improvements of the floatable rivers and the construction of permanent ways to the market from a suitable collection point for the timber from a large number of forests. There is, however, in the Punjab little scope for such permanent projects and the projects will generally be of a local and temporary nature. In such cases though the forest officer is saved two large items of expenditure in the form of upkeep and interest charges he is at the same time faced with the necessity of recovering his capital expenditure within a short period. Logging projects will therefore seldom be economical unless there is a continuous and rapid removal of all the exploitable material in the tract which the project serves. It is obvious that where such wholesale fellings are carried out it will be impossible as a rule to regenerate the forest without artificial assistance. In the past our dependence on natural regeneration has forced on us long regeneration periods which have necessitated economic extraction being subordinated to the preservation of every patch of regeneration. Whereas in the past we have been content to follow the European practice in a country where the European conditions do not exist, we ought, as has already been pointed out by several Indian forest officers, to study rather the methods of extraction practised in the American continent where the conditions are more similar to our own. Whilst we must, as in the past, insist on the replacement of the woods which we fell, it is likely that we shall in the future have to subordinate our methods of replacement to the demands of economic extraction. In this case we shall have to provide for the future of the forests by allotting a percentage of the increased profits to expensive artificial works.

In this connection attention may be called to the economic fallacy of debiting the cost of replacement against future yield by setting the same plus compound interest against the estimated

value of the future crop at maturity. If a system of concentrated fellings necessitating replanting can be shown to give an increased revenue of say Rs. 1,000 per acre, then it is financially sound to spend say Rs. 500 per acre on replanting, even should the cost of this plus compound interest amount to 100 times any probable future value of the crop.

Unfortunately, however ready Punjab forest officers may be to change their preconceived ideas regarding the methods of regenerating their hill forests, there are large areas of coniferous forest, which cannot by any possibility be logged at present and others which never can be.

The majority of forests which have been under working-plans are now incapable of being logged because, owing to their previous working on the selection system, there is insufficient material on any one area to pay the cost of any logging scheme. Such forests can only be logged provided they are in close proximity to a floating stream, *e.g.*, certain deodar forests in upper Bashahr which have already been logged for several years.

The only forests in the Punjab Himalayas which are at present pre-eminently suitable for concentrated logging operations are the fir and spruce forests which have never been worked. Many of these contain a quantity of exploitable material comparable to that of any primeval forests in the world.

A scheme has lately been drawn up with the help of an American expert for logging such forests in one valley of the Bashahr Division. The situation of the forests is fairly typical and the easiest locality has not been selected. There is a lead of about 12 miles to the Sutlej river and the estimated annual yield from the valley is about 9 lakhs of cubic feet in log for a period of 10 years taking into account trees with a girth exceeding 4½ feet only. The initial capital expenditure is estimated at about 4 lakhs of rupees to cover all the works required for the area to be felled in the first four years ; a large part of this expenditure is however debitable to the whole area and 2·32 lakhs is for stream improvement which will be of permanent value. The works to be constructed are rolling roads, slides, a flume and splash dams.

It is calculated that 1,440 acres will be capable of being worked by concentrated fellings and in addition timber will be extracted from other areas in selection and improvement fellings. The scheme is calculated to give a profit of from 3 to 6 lakhs of rupees annually for ten years and when it is completed there is scope for other equally promising schemes. The yield which it is proposed to extract at present is certainly less than the possibility of the spruce and fir forests in the Bashahr Division. The cost of re-afforestation will be debitable to the profit.

An essential part of the scheme is the erection of a modern saw-mill where the Sutlej river reaches the railway in the plains; the cost and profits of this have not been included in the above figures. It is perfectly useless extracting logs in any quantity unless a saw-mill is in existence to deal with the outturn. At the present time a small quantity of deodar and blue pine logs are extracted from Bashahr, but owing to the scarcity of sawyers it has been found impossible to sell the latter at a reasonable rate this year, in spite of the fact that blue pine scantlings fetch the same price per c.ft. as deodar sleepers sold to the railway.

In all future working-plans the claims of economic extraction will have to be considered and for the more important areas it would appear advisable that the working-plan's officer should obtain the advice of a lumber expert before making the allotment of the felling areas.

M. R. K. JERRAM,
*D. C. Forests.*

## INDIAN TIMBERS.

*Professor Troup's paper on the above as read before the Royal Society of Arts, Indian Section, on January 21st, 1921, was published in our issue for May. This month we give the discussion which followed the reading of the paper.*

### DISCUSSION.

Sir Bradford Leslie, K.C.I.E., said that before India imported iron it was entirely dependent on charcoal iron produced in that country direct from the ore, and many miles of the track of the

East Indian Railway were ballasted with the slag from that industry, indicating that the works in Bengal at the time were very extensive. It appeared to him that it would be exceedingly valuable if the manufacture of charcoal iron could be re-established in India as a village industry because that iron was far superior to any other description of iron, especially for wire drawing, tin-plate work, and railway axles, which required to be extremely tough. Much of the timber which was now used as fuel for locomotives would, in his opinion, produce sufficient charcoal to manufacture a very large quantity of that superior charcoal iron, and there were mountains of high grade ore in Bengal which were particularly suitable for the purpose.

Professor Troup thought that Sir Bradford Leslie was probably referring to the days before the discovery and the development of coal in India. Since the advent of coal in India the charcoal industry, which was at one time of great importance, had considerably dwindled, and, as far as he knew, it no longer existed on the scale it reached in the days to which Sir Bradford referred.

Sir Bradford Leslie said he was advocating the revival of what was formerly a very extensive industry which produced iron superior to any of the iron imported from Europe.

Professor Troup said he thought the Forest Department would welcome the revival of such an industry, because there was always a certain amount of waste material in the forests which might be profitably disposed of in that way.

The Chairman (Sir Claude H. A. Hill), after paying a warm tribute to the interesting character of the paper read by Professor Troup, said it was perhaps fortunate that, owing to the geographical situation of the coniferous timbers of India, there was little or no risk of their being exploited to excess in the way in which similar timber had been exploited in the United States and Canada, thus causing grave anxiety in regard to future supplies. It must be admitted that the Government of India, while they had taken the lead within the Empire in scientific forestry and its development, had not on the whole proved very successful in the commercial exploitation of Indian timber, and that was the direction in which

he hoped the revised arrangements for forest administration might progress in the future. Very few people realised the enormous timber resources of India, the extensive areas over which they were spread, and their immense variety, upon which it was hoped, some day, the Empire would be able to draw. Mr. Howard, of the well-known timber firm, had recently compiled a very valuable catalogue of timbers, but it did not give either the distribution in such a way as to make it clear to the average reader or the quantitative resources of the different varieties, and Professor Troup had enlightened those interested in the subject in those respects. Another point to which he wished to refer was the failure hitherto of the Government of India to enter upon a go-ahead policy in connection with commercial firms for the exploitation of Indian timber, and it was greatly to be wished that, with the co-operation of business men, an improvement would take place. Hitherto the British Empire had failed lamentably to develop a forest policy. This fact was emphasized at the recent Forestry Conference, at which delegates from all over the Empire bore unanimous testimony to the need for educating the public in connection with the formulation of a forest policy of a co-ordinated kind. It was to be hoped that the Empire had awakened out of its lethargy in that respect, and the various developments which had recently taken place seemed to be promising. First of all there was the assembling of the Forestry Conference which was the work of the newly-constituted British Forestry Commission ; then came the exhibition of timbers, which aroused a quite unexpected and very gratifying degree of interest ; and quite recently a most interesting paper on forestry development within Great Britain was read before this Society by Lord Lovat. A further stage was the exceedingly interesting description of the timber resources of the Indian Empire which had just been given by Professor Troup. The author had stated that timber companies employed assistants without any previous training on the technical side of their work. The Forestry Commission were arranging for education in various grades of forestry, and it was earnestly to be desired that advantage should be taken of the

opportunities thus offered, and that, as in the case of all other businesses of a scientific kind, merchants interested in timber exploitation would take care to see that their employees were given the opportunity of securing a scientific training. The paper was designed to indicate the opportunity offered to British and to Indian enterprise for the development of the timber trade of India. The author had described the forest resources in order that those who wished to consider the question of further development might know the conditions and to what authorities they should apply. Although he knew that politics had to be avoided in connection with such meetings of the Society, he desired to make a few remarks regarding the political situation, since it might be held to affect the value of the opportunity which now presented itself. He had heard it said, for example, that India was in such a condition of unrest that no one in his senses would care to invest money for the further exploitation of anything connected with India; and, in view of the kind of information which was from time to time telegraphed to England or published in England, he was not surprised at that kind of remark. He had spent a good deal of his life in India and had only recently returned from that country, but he would have hesitated to comment very definitely on the value of the information which was from time to time telegraphed home, had not his own impression been confirmed by enquiries from those who had still more recently come home. It was abundantly clear that the unrest in India had been very greatly magnified, and its extent exaggerated. In point of fact, his latest information from a valuable source was that the situation in September, October, and November, was definitely better than it was last April. He thought those remarks were relevant, because it was desirable to correct what he could not help feeling was a mistaken impression in regard to the political atmosphere, and because it appeared to be genuinely the case that people were hesitating to develop trade relations with India on the score of the political situation. He did not feel qualified to speak on the really justifiable cause of trade hindrance with India, namely, the fluctuations in exchange; but, so far as the

political side was concerned, he was glad to take the opportunity of expressing his own conviction that the news which had been published was both misleading and mistaken. He desired to suggest to the hospitality of the Royal Society of Arts that the process of exciting interest in forestry matters, which had taken the course he had described, should be followed up, if it could conveniently be arranged, by getting a commercial man interested in the timber trade to read a paper, in continuation of the present paper, giving the commercial side of the case.

Mr. H. J. Elwes, F.R.S., said that one of the things that struck a newcomer to India in travelling from Bombay to Calcutta or from Bombay to Madras or Madras to Calcutta, was the extraordinary absence of timber. A great deal of bamboo and of scrub jungle was to be seen, but real timber trees were to be met with in only a few places. He was perfectly ready to admit, however, that in particular areas there were enormous resources of fine timber, but he was afraid he should not live to see the day when the Indian ryot would live in a better house than the wattle-and-daub hut in which he was compelled to live at present, owing to the absence of, or the cost of, timber. When the ryot could afford to use timber for his house, he did not believe there would be enough accessible timber in India to supply its own needs. Where the dense population was found there was little but shaded fruit trees; where the timber was found there were few roads or people. That, however, was a matter which our descendants would have to consider. Some of the Indian woods were very beautiful indeed, and he had been struggling for fifteen years on exactly the same line as the author to convince architects, timber users and the cabinet-makers of England that it would be worth their while to use them in this country. But, unfortunately, they had not adopted such a course. As long as merchants could get a cargo of foreign timber at a cheap price, without regard to quality, they would not bother their heads about buying 10-ton lots from India, however beautiful the timber might be. He believed the author would find that the vested interests which had existed for generations of firms engaged in the American, Canadian and Baltic timber trade

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would prove most difficult to overcome so far as Indian timber was concerned. It was, however, largely a question of price. The author knew much better than he did that the one thing which governed the value of timber was what it cost to get it out of the forest where it grew to the place where it was going to be used, and that was a point upon which it was extremely difficult to obtain information in any country other than America. In order to be able to compete with other countries, the Indian Government must study the most economical and up-to-date mechanical methods of handling timber in the woods, and he was very glad to find, when he was in America the previous year, that the Indian Government had sent an officer to America for the purpose of examining that problem. That gentleman had recently produced a report which had been published at the expense of the Government of India, and he desired to express his thanks to the Director-General of Forests for having sent him one of the most interesting, valuable and beautifully illustrated reports that he had ever seen produced by any Government official, either in Europe or in India. It would repay the cost of the investigation and the printing of the report a thousand times over to the Indian Government if the methods and devices illustrated in the book were made use of as far as possible. The author of the report, however, very rightly said that it was largely a question of cost. If first class forest workers could be obtained for four annas a day such as he used to get in Sikkim fifty years ago, it was open to discussion whether primitive methods would not in the end be cheaper in actual operation than very costly machinery which had to be superintended by an expert. To put valuable machinery into the hands of ordinary natives, or even ordinary Englishmen who had no practical knowledge of the use of such machinery, would lead to enormous waste and to many serious accidents, which would probably cause a great deal more trouble than the machinery was worth. Such questions would have to be very seriously considered by the Indian Forestry Department. After paying a visit to Japan and seeing the methods that were adopted there, he thought it might be wise for the Indian Forestry

Department to send an officer to Japan to study the work being done there. He hoped the Chairman's suggestion, that the present paper should be followed by one written from the commercial side, would be adopted. Mr. Alexander Howard was the solitary timber merchant in England who had ever given him much information about timber, some of which it was very hard to obtain, and when Mr. Howard came back from India, he thought he would be able to follow up the present paper with one which might throw a good deal of cold water upon many of their wishes and hopes, but which would, at any rate, give a better idea of what was practicable from the timber merchant's point of view than the information they possessed at present.

Sir Charles Armstrong said the paper was so interesting and useful and so full of practical advice that he hoped it would be distributed amongst those who were taking a keen interest in the development of Indian timbers, and also amongst those who ought to do so. He had often wondered why it was that Indian timber had not been used in greater quantities in this country, particularly for furniture making. He agreed with the previous speaker, that the makers of this country did not care to handle a small amount of any particular wood; they liked to buy an article in quantity which they could obtain with great ease. Twenty years ago, when he was furnishing his bungalow in Bombay, he had the whole of the furniture made of Burma teak, by a first-class maker. When he left India, in 1914, he brought the furniture home with him, and he looked upon it as a first-class advertisement for a very excellent wood. It was admired by everybody, including furniture makers in this country. One of the difficulties connected with the use of certain Indian timbers was that they had to be transported a great distance before they reached a port. The heavy cost of handling and transporting the timbers to the port of embarkation seemed to place all the Northern Indian timbers out of the market altogether. In addition there was a sea freight of at least 6,000 miles, which added very considerably to the total cost, particularly as the distance was very much greater than that which timber from Canada, Scandinavia and other countries on the

Continent had to travel. Probably that was one of the great reasons why trade had not freely developed between India and this country. The G. I. P. Railway, of which he was Chairman, started in Bombay and ran in a north-easterly direction to Nagpur, Jubbulpore and Delhi, passing through an area in which there was no timber of any great value. Therefore any Indian timber that was used on the railway cost a great deal before it reached the line. As far as he remembered, the Indian woods used on the G. I. P. were the deodar, the sal and the pyinkado. The first two were very good indeed for rough work, for the flooring of wagons and also for sleepers, but sleepers were to some extent attacked by white-ants. They were not very good for carriage work, as they were apt to warp and twist. Another wood, Canara teak, had been found most excellent for carriage work of all kinds. It was a very ornamental wood, which the railway company was always glad to use. At the same time, Burma teak was the most popular timber. It was very easily worked, but unfortunately it cost a considerable sum of money. He doubted very much whether there would be a great market for Indian timbers in this country, although he thought there ought to be a great market for them in India itself. A great deal was heard at present about industrial development in India, and that was undoubtedly one of the industries which might be developed on a large scale. The Chairman said that the Government of India were taking a much greater interest in forest work than they had done in the past, and he thought development on those lines was likely to produce very good results. He was very glad indeed to hear the Chairman's opinion that many of the telegrams and letters received from India in connection with what was called the unrest in that country were very much exaggerated. He agreed. Personally he thought a great deal of the present industrial unrest in India, as distinct from the political unrest which concerned a certain class of extremist politicians, had been brought about to a very large extent by he results of the war, particularly the high cost of living. The cost of living had more than doubled on the railway with which he was connected. Statements were placed before him when he

was in India a few months ago, showing that the cost of the ordinary necessaries of life had risen by anything from 200 to 300 per cent., and it was very difficult for him to say that the figures were wrong. It had been quite impossible to raise wages to the same extent, and a great deal of the industrial unrest had been due to that cause. He did not see much hope of alleviation in that respect at the moment. Unfortunately the last monsoon was unsatisfactory, and, so far as was known at present, there had been no winter rains in India. It therefore looked as if food prices would remain at a high level for some time to come. He thought, however, that if the next monsoon was satisfactory conditions would improve, and that consequently there would be much less unrest among the population generally.

Mr. H. J. Elwes said he was informed on the previous day by the Agent-General for British Columbia that quite recently a very large quantity of British Columbia creosote wood had been shipped to Calcutta. If that was a fact it seemed to show that the cost of transport from the Himalayas was even greater than the figure mentioned in the paper. Having regard to the fact that about ten times more was paid for a day's labour in British Columbia than in India, one would have thought that the competition of British Columbia with Indian grown woods was impossible.

Mr. A. N. Howard thought it was a great pity that Mr. A. L. Howard could not be present to speak, because, with his wide knowledge of the subject, he would have been able to describe some of the very considerable successes that were being met with in the distribution of Indian timber. In that connection, besides the invaluable help of such high experts as the author, who always helped in every way he could, there was one thing that was of even more assistance, and that was the knowledge that Indian timbers were essentially good—that their characters and decorative qualities were almost unequalled, and that in comparison with all the well-known decorative timbers they were, as the Americans would say, a sound proposition. He thought he could observe without fear of contradiction that everybody in his firm was thoroughly convinced that the Indian timbers were sound, and that it was

only British conservatism and natural dislike for anything new that had kept the Indian timbers out of their own. The war did more than anything else to lessen that conservatism, and the users of timber in this country began to realise that English and Colonial timbers should be fostered, and that it was no good relying on enemy countries for supplies of timber in war time. It was found that there was no equal in the world to English ash for aeroplane manufacture, and that there were quite a lot of good qualities in English oak which had been rather overlooked previously. He was sorry to say that this country was already lapsing into its former prejudices, and that the outlook at the moment for English timber was far from promising especially with the present increased railway freights. It was to be hoped, however, that the British Empire Forestry Conference and the Empire Timber Exhibition would do much to counteract that tendency as far as Colonial timbers were concerned. It was said that it took a real salesman to sell anything that people did not want, but he thought there should be a rider added, that it made a lot of difference to the struggling salesman if he was thoroughly convinced in his own mind that he had got a good proposition to offer. That was so in the present case. It was known that there was no equal to padauk, laurel wood and Indian silver greywood for interior decorations, and that pyinkado and Indian Gurjun wood were the woods to be used where strength and durability were desired. It was probable that the last named was going to replace teak for a number of purposes. The results of the Empire Timber Exhibition had far exceeded the most optimistic expectations, and his firm had in consequence been literally besieged with enquiries and orders. Upwards of 200 enquiries at the Exhibition itself were dealt with, and innumerable samples of the various woods were despatched. Many buildings which were being put up at the present time in London and in the provinces would include panelling, doors, floorings and fittings done throughout in Indian silver greywood, padauk, laurel wood and Gurjun wood, and, as already mentioned by the author, the railways had taken up the wood in earnest. The author mentioned the importance of determining the

best methods of seasoning the various timbers, and also getting out and shipping them in the correct specification and condition. Those were points of the utmost importance. Many cargoes of valuable timbers had been entirely ruined through ignorance of how to convert and through being shipped in a too fresh condition or cut at the wrong time of the year. It was also very important to know how actually to work the various materials in the shops. Every timber should be dealt with according to its own peculiarities, and, while it was found that the best finish could be obtained in one case from a plane, in other cases it could only be done with a scraper. He had been assured by one of the greatest experts in the actual working of decorative woods, that Indian woods, if handled properly, were not more expensive to finish than mahogany, oak, etc., and that an even better finish could be obtained.

Mr. J. S. Corbett reminded the meeting of a resolution passed at the Empire Forestry Conference to the effect that it would be in the interests of all concerned if an Empire Forestry Association were established. With the assistance of the Chairman, those who were interested in the movement would soon be in a position to make public the aims and objects of such an Association. The author had referred in the paper to the need of better education and more technical expert foresters being available. In addition to educating forest officers it was absolutely necessary to educate the general public as to the resources of the Empire, particularly with regard to the industry of forestry. The lack of knowledge that existed was, if anything, even more apparent with regard to the timbers of the British Islands. The establishment of an Empire Forestry Association would be of the greatest benefit not only to those who grew timber and were connected with its exploitation, but also to those who traded in timber of every variety. It was hoped that the scheme would appeal to all interested in forestry, from the grower to the merchant and the consumer. When the scheme was put before the public generally he hoped it would appreciate the importance of the subject and would see that the organisation was the success it ought to be.

Sir Murray Hammick, K.C.S.I., C.I.E., in proposing a vote of thanks to the author for his interesting and instructive paper, said he had spent the greater part of his life in the south of India, and had taken much interest in forestry during his service there. He desired to emphasise the point that not only should the Forestry Department in India exploit the public in this country, but that it could do a great deal more than it had hitherto done in putting forward better material than it was at present possible to find in the markets of India. He had had a good deal of furniture made in India from Madras timbers, and he had suffered a good deal through unseasoned and unsuitable timbers having been used. He had never been able to get a good timber without taking a considerable trouble to find it. There could be no doubt that an enormous industrial development would take place in India and that a great local demand for timber would arise. Porto Novo, south of Madras, in which he had served, had been the site of an iron foundry, charcoal being used for the purpose. Both the iron and the charcoal had been sent down from the Ghats by the Cauveri river, the foundry being in Porto Novo. Whatever might have been the success of such an undertaking in Bengal, the only record of success in Madras consisted of the epitaphs of the great number of employees who died at the factory, the epitaphs being inscribed on cast iron tombstones made in the factory. He did not think much else remained of the industry but those tombstones. He had, however, used in Madras very excellent steel which was made by means of charcoal, and he thought a good deal might perhaps be done in the development of the manufacture of charcoal steel in the future.

Sir Bradford Leslie, in seconding the motion, said that a previous speaker had referred to the fact that in travelling through the length and breadth of India, the absence of timber was remarkable. That, he thought, was largely due to the denudation of timber for the purpose of providing fuel for the railways. Owing to the want of coal, huge tracts of timber had been cut down and it was very important indeed that those areas should be re-afforested. If that were done it would have an effect

upon the climate, because every ton of timber grown neutralised the heat of the sun to the corresponding extent, and by tempering the climate the rainfall was increased and regularised. Where bare hills and rocks were exposed to the sun they got hot during the heat of the day and gave off that heat at night, thus preventing condensation of the moisture. Re-afforestation of denuded tracts was therefore a very important subject to which attention should be paid.

The Chairman, before putting the resolution, announced that letters regretting their inability to be present had been received from Lord Crewe, Lord Novar, Sir John Stirling-Maxwell, and others. He was particularly sorry that Lord Novar and Sir John Stirling-Maxwell, had been prevented from attending, because he hoped they would be the champions of the Empire Forestry Association, to which Mr. Corbett had referred, and which was about to be launched. He ventured to appeal to all interested in forestry to do their utmost to help to place that Association on an influential footing.

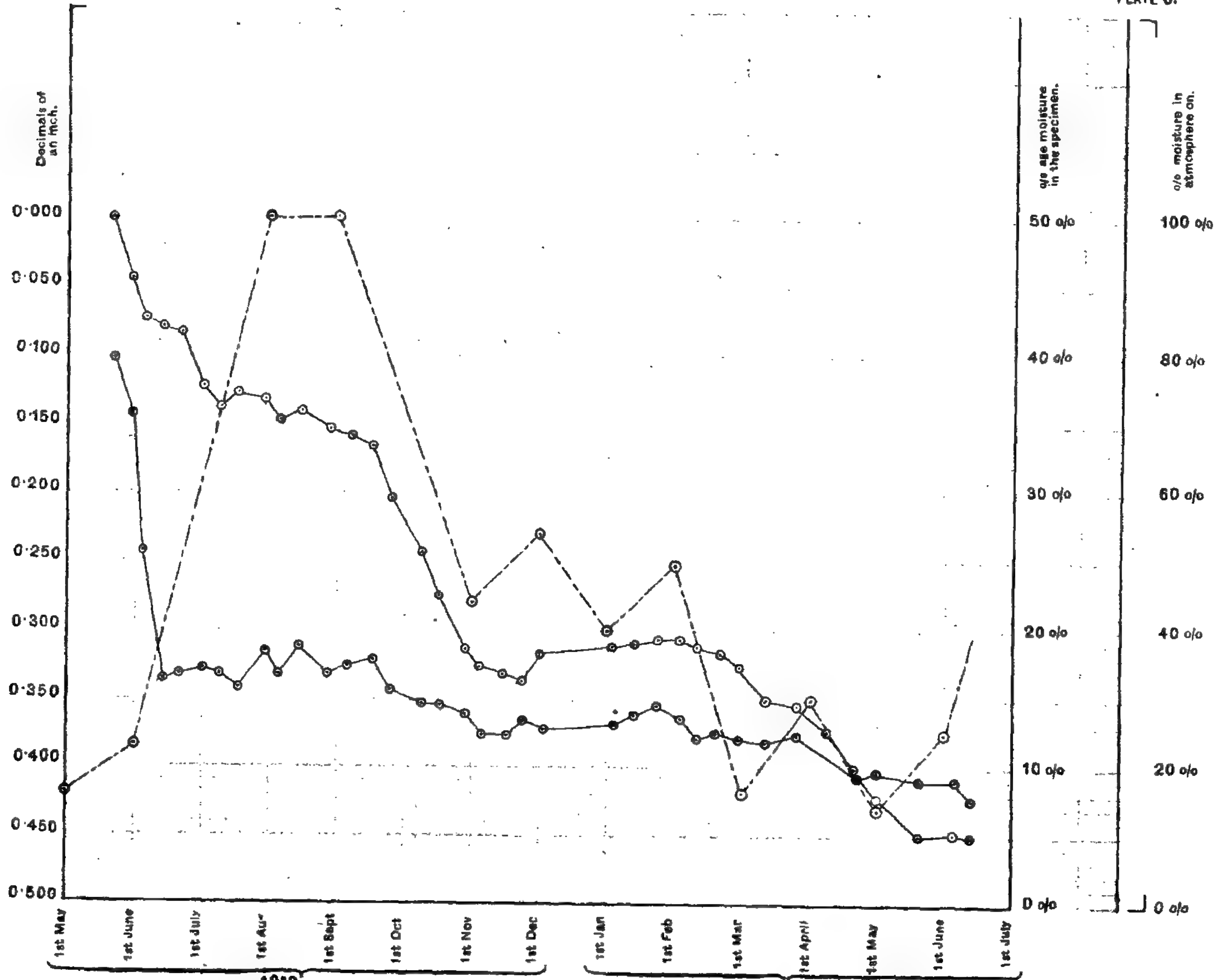
The motion was carried unanimously and the meeting terminated.

## NOTE ON THE CONTRACTION OF SAL (*SHOREA ROBUSTA*) TIMBER WHILE SEASONING.

Forest Bulletin No. 15, 1913, entitled a " Note on the Technical Properties of Timber, with special reference to *Cedrela Toona* wood, while seasoning," and a similar Bulletin No. 37, dealing with *Pinus longifolia*, refer to the contraction which takes place in these timbers, while seasoning. A similar experiment has heen carried out with *Shorea robusta* timber and special daily records taken as to expansion or contraction in connection with an enquiry being carried out by the Forest Zoologist.

The instrument with which these experiments have been carried out and the mode of procedure adopted were the same as in the previous experiments, details of which are recorded in Bulletin No. 15.

PLATE 8.




NOTE.—The black curve represents the expansion and contraction of the sal plank
The red " " " percentage of moisture in the specimen
Dotted black line " " " " " " atmosphere

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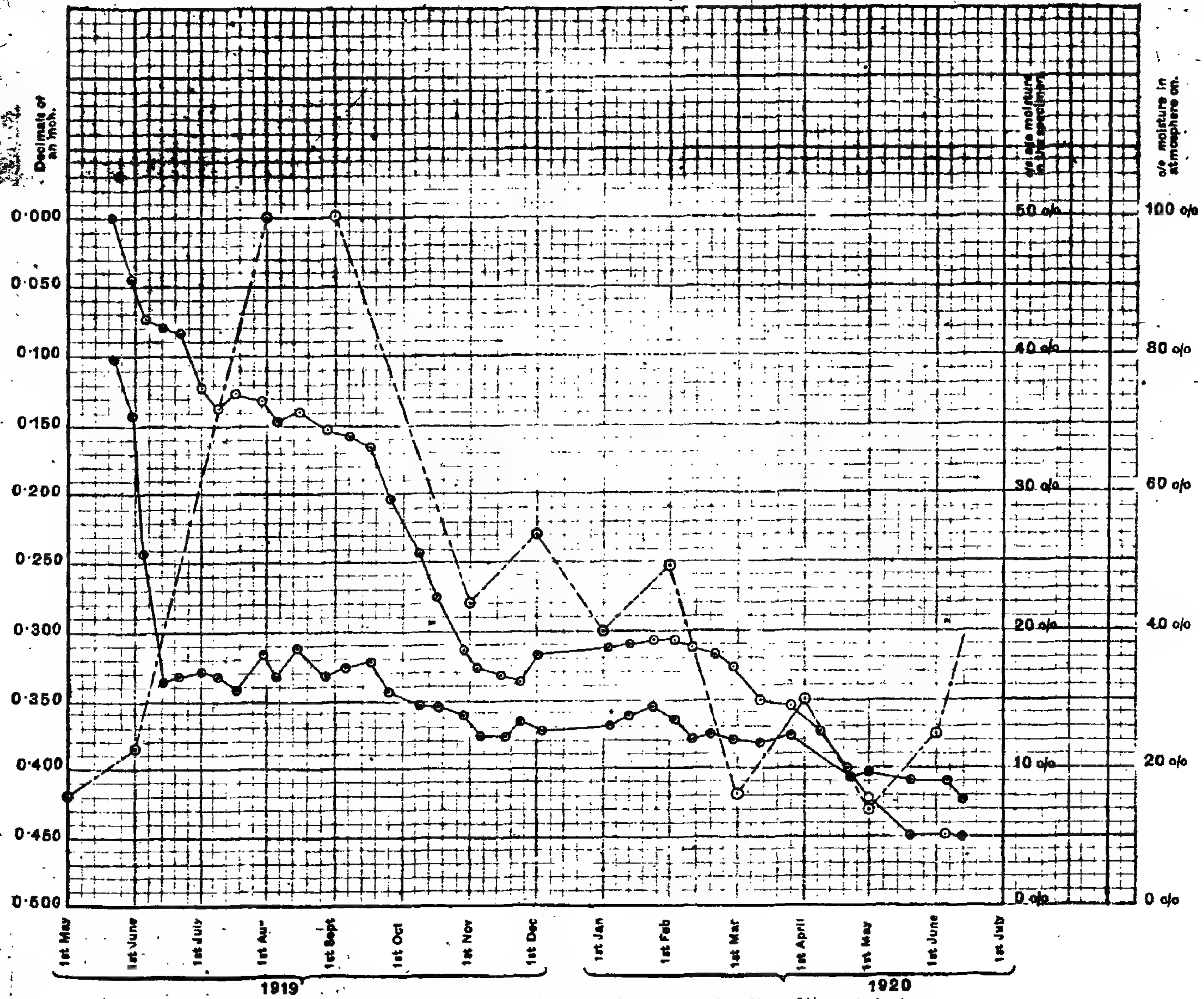
The specimen plank measuring 12″ × 12″ × 1″, which was put into the testing machine, was cut on the quarter, and the records of expansion and contraction taken across the grain. The tree from which the plank was taken was felled on the 17th May 1919, and cut from the log two days later, at which time the timber contained 39·87 % of moisture. The experiment commenced on the 20th May 1919, and daily readings taken up till the 12th June 1920.

To illustrate clearly what took place in the timber during the time the plank was under observation, curves have been plotted showing (i) the amount of contraction and expansion which took place, (ii) the percentage of moisture in the timber on corresponding dates of observation, and (iii) the humidity in the air on the same dates.

The results obtained are instructive, the most important point being that the plank contracted to a maximum amount of ·455 of an inch over 12″ surface, or for practical purposes ½″ per foot. This being the case, it is not difficult to realise what would be the effect of putting green sal boards into a 3 ft. 6 in. door, as a matter of fact many people living in localities where sal is easily procurable have suffered to a more or less degree from such a practice.

The rate of contraction was throughout fairly uniform, being somewhat faster just at first and again after the monsoon period. This is without doubt due to the fact that the specimen plank was put into the machines just before the commencement of the rains, and that the high humidity in the air during the first period during which observations were made, checked rapid evaporation from the specimen. Winter rains in December and early February raised the humidity in the air, which at once affected the moisture percentage in the timber, resulting in a corresponding degree of expansion. In June 1920 the timber was thoroughly seasoned and contained 7·5 per cent. of moisture, at which time the experiment was closed. It would have been extremely interesting to know whether the sal plank would have re-absorbed moisture and expanded seriously during the monsoon of 1920. As this cannot




NOTE.—The black curve represents the expansion and contraction of the sal plank

The red " " " percentage of moisture in the specimen

Dotted black line " " " " " " atmosphere

Zinco. May, 1921.—No. 2881. 350

now be ascertained, and especially as the Forest Zoologist is anxious to have information on this point, it is proposed to repeat this experiment during 1920-21.

R. S. PEARSON,
*Forest Economist.*

## THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C. F. C. BEESON, ESQ., M.A., I.F.S., F.E.S., FOREST ZOOLOGIST.

PART VI.

(*Continued from* "Indian Forester," *January* 1921, *pp.* 21—25.)

### SCARABÆIDÆ.

Sub-family CETONIINÆ.

**Agestrata orichalcea**, Linn.

Wood borer.—*Pandanus* sp.[69],

Distribution.--[Ceylon; Travancore; Bombay; Sylhet, Assam; Tenasserim; Andaman Islands; Malay Peninsula; Sumatra; Borneo; China.]

**Diceros childreni**, Westw.

Rotten wood borer.—*Cassia Fistula.*

Distribution.—[Bengal; Khasia Hills, Assam; Gorakhpur, U. P.]

**Heterorrhina mutabilis,** Hope.

Defoliator.—*Glochidion* sp.

*Distribution.—[Mussoorie, Dehra Dun, U. P.; Nepal; Bhutan]*; West Almora, U. P.

**Jumnos roylei,** Hope.

Rotten wood borer.—*Quercus* sp.?

Distribution.—[Landaur, U. P.; Bhutan; Sylhet, Assam]; Mussoorie, Naini Tal, W. Almora, U. P.

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[69] Arrow, G. S., Faun. Brit. Ind., Cetoniinæ, 1910, p. 193.

**Oxycetonia albopunctata**, F.

Defoliator.—Flowers of various trees, shrubs and monocotyledons.

Distribution.—[Dehra Dun, U. P.; Pusa, Bihar; Lebong, Khasia Hills, Sylhet, Assam; Kanara, Bombay; Burma; Ceylon]; Naini Tal, West Almora, U. P.

**Protaetia aurichalcea**, F.

Defoliator.—*Lantana aculeata*.[70]

Distribution.—[Dacca, Calcutta, Bengal; Chapra, Bihar; Mysore; Coimbatore, Madras; Dharwar, Bombay; Mauritius]; Kanara, Bombay; Dehra Dun, U. P.

**Protaetia neglecta**, Hope.

Defoliator.—*Mallotus philippinensis.*

Root-grub.—*Cedrus Deodara.*

Distribution.—[Simla, Punjab; Naini Tal, U. P.; Nepal; Manipur, Assam]; Kashmir; Rawalpindi, Bashahr, Kulu, Punjab; Chakrata, Mussoorie, Dehra Dun, Ranikhet, Central Almora, Tehri Garhwal, U. P.

Sub-family DYNASTINÆ.

**Eupatorus hardwickei**, Hope.

Stripping bark.—*Alnus nepalensis.*

Distribution.—[Assam]; Kurseong, Bengal; Naini Tal, W. Almora, U. P.

**Oryctes rhinoceros**, Linn.

Crown borer.—*Borassus flabelliformis*, *Cocos nucifera*, *Oreodoxa regia*, *Phœnix sylvestris* and other palms.

Distribution.—[Ceylon; Travancore; Mysore; Madras; Coorg; Bombay; C. P.; Bengal; Burma; Tenasserim; Siam; Annam; F. M. S.; Malay Archipelago; Formosa; Corea, etc.]; Cuttack, Singhbhum, Bihar and Orissa.

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[70] Ramachandra Rao, Mem. Dept. Agr., India, v, 6, 1920, p. 290.

**Xylotrupes gideon,** Linn.

Stripping bark.—*Poinciana regia.*[71]

Distribution.—[Calcutta, Kurseong, Bengal; Shillong, Sibsagar, Cachar, Tezpur, Khasia Hills, Assam; Bombay; Coorg; Travancore; Ceylon; Malay Archipelago]; Simla, Punjab; Chakrata, Mussoorie, Dehra Dun, U. P.; Chittagong Hill Tracts, Assam; Pyinmana, Meiktila, Burma.

Sub-family MELOLONTHINÆ.

**Apogonia clypeata,** Moser.

Defoliator.—*Tectona grandis.*

Distribution.—N. & S. Toungoo, Katha, Burma.

**Apogonia granum,** Burm.

Defoliator.—*Tectona grandis.*

Distribution.—[India]; S Toungoo, Katha, Burma.

**Autoserica insanabilis,** Brenske.

Defoliator.—*Tectona grandis.*

Root-grub.—*Citrus medica,*[72] *Sacharum officinarum.*[72]

Distribution.—[Pusa, Bihar]; N. and S. Toungoo, Burma.

**Brahmina coriacea,** Hope.

Defoliator.—*Desmodium tilliæfolium, Ficus carica,*[73] *Pyrus communis,*[73] *Pyrus Malus,*[73] *Spiræa sorbifolia, Vitis* sp.[73]

Distribution.—[Kulu; Pusa]; Rawalpindi, Kangra, Punjab; Chakrata, Dehra Dun, Mussoorie, Ranikhet, U. P.

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[71] Stebbing (Ind. For. Ins., 1914, pp. viii) illustrates twigs of *Poinciana regia* with deep girdles resembling the work of Lamiids or Bostrychids and received from Pyinmana in 1907. Material received from Meiktila in 1911 consists of twigs with the bark gnawed off in irregular patches; similar damage to indigo plant is recorded in Proc. 3rd Ent. Meeting, 1919, p. 181. This species is known to injure the young leaves of cocoanut in Sumatra and the F. M. S.

[72] Proc. 3rd Ent. Meeting, 1919, p. 165.

[73] " " " " " p. 167.

**Holotrichia intermedia,** Brenske.

Root-grub.—*Cryptomeria japonica.*

Distribution.—[Darjeeling ; Cochin China] ; China.

**Holotrichia longipennis,** Blanch.

Defoliator.—*Quercus incana, Rubus lasiocarpus.*

Distribution.—Kangra, Punjab ; Dehra Dun, Mussoorie, Naini Tal, W. Almora, U. P.

**Holotrichia problematica,** Brenske.

Defoliator.—*Eugenia jambolana, Shorea robusta, Terminalia belerica.*

Root-grub.—*Shorea robusta.*

Distribution.—[Kashmir ; Haldwani, Gorakhpur, U. P.] ; Dehra Dun, U. P.

**Holotrichia tuberculata,** Moser.

Defoliator.—*Tectona grandis.*

Distribution.—[China] ; Myitkyina, Katha, N. and S. Toungoo, Burma.

**Lepidiota bimaculata,** Saund.

Defoliator.—*Shorea robusta.*

Distribution.—[Sikkim ; Goalpara, Naga Hills, Assam ; Tonkin] ; W. Almora, U. P.

**Leucopholis pinguis,** Burm.

Defoliator.—*Erythrina* sp.

Root-grub.—*Cinnamomum zeylanicum,*[74] *Coffea robusta,*[74] *Hevea braziliensis.*[74]

Distribution.—[Ceylon.]

**Serica alcocki,** Brenske.

Defoliator.—*Mallotus philippinensis.*

Distribution.—[N. West Himalayas] ; Dehra Dun, U. P.

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[74] Green, E. E. Trans. 3rd Inter. Congr. Trop. Agric., 1916, p. 623.

Sub-family RUTELINÆ.

**Adoretus bimarginatus,**[75] Ohaus.

Defoliator.—*Bombax malabaricum.*

Distribution.—[Dehra Dun, U. P.; Ganjam, Madras; Pusa, Bihar; Sikkim; Darjeeling, Bengal]; Lakhimpur, Assam.

**Adoretus caliginosus,** Burm.

Defoliator.—*Dalbergia Sissoo.*

*Distribution.—[Kangra, Punjab; Sikkim; Sarda, Bengal;* Surat, Belgaum, Bombay; Nilgiri Hills, Madras; Barabudin Hills, Mysore; N. Coorg; Jorhat, Assam; Tharrawaddy, Rangoon, Burma]; Dehra Dun, Gorakhpur, U. P.

**Adoretus epipleuralis,** Arrow.

Defoliator.—*Tectona grandis.*

Distribution.—[Tharrawaddy, Burma; Cambodia; Cochin China]; S. Toungoo, Katha, Shwegu, Burma.

**Anomala dalbergiæ,** Arrow.

Defoliator.—*Dalbergia latifolia.*

Distribution.—[Nilambur, Madras.]

**Anomala dimidiata,** Hope.

Defoliator.—*Berberis* sp., *Cratægus* sp., *Butea frondosa, Pyrus communis,*[76] *Pyrus Malus,*[76] *Rubus ellipticus.*

Distribution.—[Zhob, Baluchistan; Kashmir; Rawalpindi, Kangra, Kulu, Simla, Punjab; Naini Tal, Ranikhet, Central Almora, U. P.; Pusa, Bihar; Nepal; Sikkim, Shillong, Manipur, Khasia Hills, Assam]; Dehra Dun, U. P.; Buxa, Bengal; Goalpara, Assam.

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[75] The following corrections are to be made in the nomenclature of the species of *Adoretus* cited by Stebbing, 1914, Indian Forest Insects, p. 87:—

*Adoretus caliginosus*, var. *bicolor* = *Adoretus bicolor*, Brenske.

*Adoretus bangalorensis* = *Adoretus versutus*, Harold.

*Adoretus cardoni* = *Adoretus lasiopygus*, Burm.

[76] Proc. 3rd Ent. Meeting, 1920, i, p. 174—p. 173.

**Anomala flavipes**, Arrow.

Defoliator.—*Alnus nepalensis*.

Distribution.—[Ranikhet, C. Almora, U. P.]

**Anomala grandis**, Hope.

Defoliator.—*Alnus nepalensis*.

Distribution.—[Ganjam, Madras; Sahibganj, Bengal; Goalpara, Sibsagar, Sylhet, Assam; Moulmein, Burma]; Darjeeling, Chittagong Hill Tracts, Bengal; Shwegu, Burma; Tavoy, Tenasserim.

**Anomala lineatopennis**, Blanch.

Defoliator.—*Prunus communis*.[76]

Root-grub.—*Aesculus indica*, *Quercus* sp.

Distribution.—[Kulu, Simla, Punjab; Dehra Dun, Mussoorie, Naini Tal, Ranikhet, Central Almora, U. P.; Nepal, Bhutan; Buxa, Bengal]; Chakrata, U. P.

# EXTRACTS.

## INDIAN KAPOK SEED AS A SOURCE OF OIL.

The silk cotton known as Indian kapok is derived from the capsules of *Bombax malabaricum*, DC., a large deciduous tree found throughout India and Ceylon. The plant is now usually included with *Eriodendron anfractuosum*, the source of Java kapok and others, in the natural order Bombacaceæ, but the group is sometimes regarded as a tribe of the Malvaceæ. It has been shown by the Imperial Institute that Indian kapok in a reasonably clean condition fully satifies all the requirements of the Board of Trade for kapok for use in life-buoys and other life-saving appliances as regards buoyancy and impermeability to water, and is, therefore, as suitable for this purpose as Java kapok (*cf.* this Bulletin, 1919, 17, 14).

Indian kapok, like that from *Eriodendron*, surrounds the seeds in the capsule, and in preparing the fibre for the market the seeds are separated. If the Indian kapok is utilised to any great extent, therefore, large quantities of the seed will be available. It is known that the seed yields an oil which is used to a small extent in India for burning.

The recorded information regarding Indian kapok seed as a source of oil, however, is not very definite, owing to the fact that little distinction has been made in the past between the seed of Indian kapok and that of Java kapok. In these circumstances the Director-General of Commercial Intelligence was requested by the Imperial Institute to forward an authentic sample of Indian kapok seed, in order that the yield and nature of the oil might be determined and the commercial value of the seed ascertained. A sample consisting of small dark brown seeds of *Bombax malabaricum* was received in May 1920, and the results of the examination of the seed at the Imperial Institute are given below.

The seeds contained 8·9 per cent of moisture and yielded on extraction with petroleum ether 22·3 per cent. of oil, equivalent to a yield of 24·5 per cent. from the dry seeds.

The oil, which was bright yellow, deposited some "stearin" on standing. It was examined with the following results, which

are compared with previous figures recorded for Indian kapok oil, and for commercial kapok oil derived from the seeds of *Eriodendron anfractuosum* :—

| | *Bombax malabaricum* oil. | | Commercial kapok oil. |
|---|---|---|---|
| | Present sample. | Figures previously recorded. | |
| Specific gravity at 15°/15°C ... | 0·9208 | 0·930 | 0·921-0·923 |
| Acid value ... ... | 9·3 | 3·0 | variable |
| Saponification value ... | 193·3 | 194·3 | 190-197 |
| Iodine value *per cent.* | 78·0 | 73·6 | 95-110 |
| Volatile acids, soluble ... | nil | ... | ... |
| Volatile acids, insoluble ... | 0·5 | .. | ... |
| Unsaponifiable matter *per cent.* | 1·0 | ... | .. |
| Refractive index at 40°C. nd. ... | 1·461 | ... | ... |
| Solidifying point of fatty acids ... | 38·0°C. | ... | ... |

From these results it will be seen that the constants of the two varieties of oil are generally similar, but that the iodine value of the oil of *Bombax malabaricum* is considerably lower than that of ordinary Java kapok oil.

The residual meal left after the extraction of the oil from the seeds was greyish white, and had a mild and not unpleasant taste. It was examined with the following results, which are shown in comparison with the corresponding figures recorded for undecorticated cotton-seed cake and commercial kapok-seed cake :—

| | Meal from *Bombax malabaricum* seeds. | | Undecorticated cotton-seed cake. | Commercial kapok-seed cake. |
|---|---|---|---|---|
| | Composition of extracted meal. | Composition of meal containing 7 per cent of fat | | |
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Moisture ... | 11·4 | 10·7 | 13·75 | 13·80 |
| Crude proteins ... | 36·5 | 34·2 | 24·62 | 26·25 |
| Fat ... | 0·8 | 7·0 | 6·56 | 7·47 |
| Carbohydrates, etc. (by difference) | 24·7 | 23·1 | 29·28 | 23·19 |
| Fibre ... | 19·9 | 18·7 | 21·19 | 23·19 |
| Ash ... | 6·7 | 6·3 | 4·60 | 6·10 |
| Nutrient ratio* .. | 1 : 0·7 | 1 : 1·2 | 1 : 1·67 | 1 : 1·5 |
| Food units † ... | 118 | 126 | 107 | 107 |

* The ratio between the percentages of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.

† The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.

The Bombax meal is thus seen to be much richer in proteins than commercial kapok-seed cake, and to have a higher nutritive value than undecorticated cotton-seed cake.

The residual meal of Java kapok seed is regarded as of low value and is principally used as an ingredient in compound feeding cakes, but the foregoing results indicate that the meal from Indian kapok seed would be a more valuable feeding-stuff.

A firm of oil-seed crushers, who examined the seed at the request of the Imperial Institute, reported that the yield of oil was rather higher than that generally obtained from Java kapok seed. The oil also appeared to be of better quality than that from the latter seed and more likely to be suitable for refining for edible purposes. If this were confirmed by commercial trials the firm were of opinion that Indian kapok seed would eventually be readily saleable, if available in commercial quantities, at a slightly higher price than the Java variety. No definite value can, however, be assigned to the oil until it has been thoroughly tested commercially.

This investigation has shown that Indian kapok seed is a promising source of oil, and that if it can be regularly shipped to the United Kingdom in commercial quantities it should find a ready market at prices equal to or higher than those realised by ordinary commercial kapok seed, which at the present time (November 1920) is worth about £15 per ton in the United Kingdom.

In view of these results it was pointed out to the Indian authorities that it seems desirable that enquiries should be made as to the quantity of kapok seed available annually in India for export and as to the price at which it could be offered in London. If these enquiries indicate that there are reasonable prospects of establishing a trade in the Indian seed, it was suggested that a trial consignment of about ten tons should be forwarded to the Imperia Institute for sale in London, so that a definite opinion as to the quality and value of the oil may be obtained.—[*Bulletin of the Imperial Institute*, Vol. XVIII, No. 3, July—September 1920.]

# CORRESPONDENCE.

## DEFOLIATION OF TEAK TREES.

SIR,—Contributions to the life histories and economics of forest insects by divisional officers are regrettably rare although there must be frequent opportunities for making important observations such as those by Mr. C. C. Dawkins, on the defoliation of teak (in the May number of the *Indian Forester*). *Pyrausta machoeralis* is a notorious but nevertheless unknown pest. A reputation in departmental literature has been established for it by a process of reiteration and misquotation but its specific identity still remains doubtful and its seasonal history is still unknown (*pace* Forest Leaflet No. 3). It is not improbable that most of Stebbing's records for the species should be transferred to *Pionea leucanalis*, a moth of similar colouring and habits. "*Pyrausta machoeralis*" is really synonymous with defoliation of teak characterised by complete skeletonisation of the leaves, that is frequently due to a faunal complex of Noctuids, Pyralids, Arctiids, etc., in which *machoeralis* is a minor factor. In some divisions registers have been maintained of the intensity of defoliation of teak expressed in percentages of *machoeralis* attack, the complement being *Hybloea puera*. Preliminary investigations made in the Nilambur plantations showed that these species were accompanied by a numerically superior group of previously unrecorded coleopterous and lepidopterous defoliators. Whether seasonal defoliation be due to one species or a group of species it is evidently of considerable importance in the establishment of pure teak crops. It is hoped that Mr. Dawkins' note will promote an expression of opinion on the economic importance of the defoliation of teak and assist in deciding if the subject requires the early and whole-time attention of an entomologist. The variation in the periods of leaf-flush and leaf-fall and the occurrence of different alternate food-plants in different parts of India indicate that the investigation of the problem will proceed more rapidly by comparative work throughout the range of the

teak, than by restricted work in one province or one type of forest. Mr. Dawkins' suggestion that defoliation at certain periods of the year may cause increased rather than decreased increment emphasises the need for an evaluation of the effect of defoliation in high forest before expensive measures are carried out with the object of preventing it; but his discovery of the serious damage done in young crops illustrates the fact that our first attempts at the practical control of insect pests will have to be made in regeneration areas not only of teak but of most forests under a uniform method of working.

C. F. C. BEESON,
*Forest Zoologist.*

VOLUME XLVII NUMBER 7

# INDIAN FORESTER

*JULY, 1921.*

## AD MAJORUM DEI GLORIAM.

Embosomed amidst the everlasting hills, the holy river wends its way through a tangle of mountains, whose snow-capped peaks tower up to the great divide between India and China, and guard the infant sources from the approach of all save the pious pilgrim, plodding his weary way to make obeisance before the throne of God. The mountains clothed with forest rise from the banks of the river, innumerable brooks of limpid water add their quota to the stream, sacred to the wife of Siva, and over all towers the snowy massif of Deotiba, whence Jamlu surveys the world of men.

And over the world of trees presides the master's hand; sitting day by day at the feet of nature, he probes the secrets of their growth; from spring time to winter, from seed fall to maturity he considers their individual whims, until the souls of the trees mingle with his soul and he knows them as a mother knows her child. He guides their destiny from the day of their birth to the day of their death; every tree stands in its appointed place; order has superseded chaos.

The mother trees stand tall and alone in the seeding felling, each one spaced according to its kind, the pines far apart, the

cedars and the spruces nearer and the silver fir closest of all The master knows their requirements, he orders each tree accordingly giving the little seedlings the light that they desire.

Around the mother trees cluster their offspring, from tiny seedlings to lusty plants they lift up their heads in the sunlight and proclaim triumph of light over darkness.

Along the banks of the river stand the long leaved pine trees, their naked stems tower to the sky, their ancient branches murmur in the breeze. Through several centuries have they stood and pondered on the beauty of the valley. Kingdoms are born and pass away, but still they stand unmoved by the vicissitudes of man contemplating only Him " to whom the ages of man are as a day and the generations of men as a moment that fleeth away."

As the elevation increases the blue pine and the cedar mingle with the long leaved pine. Each one has its appointed soil and station. The master will not attempt the violent transformation of one type of vegetation into another, humbly following the teachings of nature he will grow each tree in the place most suited to it, manipulating the proportion of species in a mixed crop almost at his pleasure so long as he makes no attempt to overweigh the great balance of nature ordained by One greater than he.

In the sacred groves of cedar dwell the deities of this land, the spirits of the forest. Around their shrines the simple peasants hold their summer festivals and offer flowers for the increase of their flocks. More desirable than any other tree, they reign supreme in their allotted place, reaching an immense age and huge size, incomparable in splendour, fit habitations of the fairies who dwell among them.

Above the cedars the spruces and the silver firs come into their own. In remote and lonely valleys their gigantic stems obliterate the light. The beams of the sun scarce penetrate the gloom beneath these mighty trees, where save for the crow of the pheasant and the tap of the wood pecker all is still. Beneath the shade of the silver fir the giant Himalayan lilies lift their heads of lovely flowers and diffuse their fragrance in the forest. The brown oak appears in places, and as the elevation increases grass glades

become interspersed with forest. The fir trees become stunted and finally disappear to give place to the silver birch, the white rhododendron and the mountain ash. These eke out their lives in a perpetual struggle with the snow; as the elevation still further increases the snow finally has the mastery and black patches of juniper are all that remain of arborescent vegetation.

Extensive tracts of alpine pasture stretch above the forest limits to the line of perpetual snow. Here is found a flora rich in many gems cultivated with much care in the rock gardens of Europe. Mecanopsis, Potentilla, Caltha, Aconite, Primula and Myosotis, the rolling hills are carpeted with their flowers, the hum of insects fills the air. Fields of Strobilanthus are mixed with the dwarf rhododendrons and the fern Osmunda stands erect by the rivulets of water.

The sheep graze on the summer pastures, nomads dig for medicinal roots and the poacher snares the musk deer secure from the attentions of the forest guard. During the winter these uplands are a wilderness of snow, a cold wind blows off the mountains, work ceases in the forest and till the return of spring all is dead.

The master contemplates his life's work, he sees the little trees he has caused to grow, he sees the perfection of nature still further glorified; and as old age creeps on he lifts up his praise to the throne of the Great Master from whom all knowledge comes and exclaims in the words of Solomon—

"Happy is he that findeth wisdom
And the man that getteth understanding;
For the merchandise of it is better than silver,
And the gain thereof than fine gold.
She is more precious than rubies;
And all the things thou canst desire are not to be compared
unto her.
Length of days is in her right hand,
And in her left hand riches and honour.
Her ways are ways of pleasantness
And all her paths are peace."

TROWSCOED.

## FOREST MANAGEMENT IN SWITZERLAND.

No one is so ready to disclaim against the disadvantages of the mixed population of Switzerland as an inhabitant of that country. It is, nevertheless, true that this variety of peoples does possess some advantages and one of the most important of these is the controlling or restraining influence that one race exerts on another. Nowhere else is this so remarkable as in the subject matter of this essay. Forestry, more truly perhaps than any other art or science, bring to the fore the salient national features of a race. This is particularly so in Switzerland where we see the Teutonic ideal of order, cut-and-dried, checking and being checked by the Latin disregard for established principles: the old comparison of northern reserve and southern abandon. That is why in Switzerland we find all problems, social, political and agricultural, surrounded by fresh ideas and being studied in quite new ways. It would not be out of place here to give a summary of the past events that have led up to the present state of matters sylvicultural.

There have been forest laws of some kind in existence—but not necessarily in force—in parts of Switzerland for many centuries. Formerly, these laws were, however, few and of small compass and power. The constant abuse of the selection forests by the continual removal of the best trees, and the natural results of such abuse convinced most Swiss sylviculturists that clear-felling and artificial regeneration provided the only sure remedies. These latter methods were applied in preference to all others from the middle of the XIXth century to the beginning of the XXth. These naturally followed the replacement of more valuable broadleaf forests by pure spruce; the production of even-aged woods which were severely damaged by wind and snow; the impoverishment of the soil. The old proverb anent an ill wind still holds true, however, and these evils were responsible to a great extent for the bountiful crop of forest laws promulgated by the cantons during the latter part of the XIXth century,

become interspersed with forest. The fir trees become stunted and finally disappear to give place to the silver birch, the white rhododendron and the mountain ash. These eke out their lives in a perpetual struggle with the snow; as the elevation still further increases the snow finally has the mastery and black patches of juniper are all that remain of arborescent vegetation.

Extensive tracts of alpine pasture stretch above the forest limits to the line of perpetual snow. Here is found a flora rich in many gems cultivated with much care in the rock gardens of Europe. *Mecanopsis, Potentilla, Caltha, Aconite, Primula* and Myosotis, the rolling hills are carpeted with their flowers, the hum of insects fills the air. Fields of Strobilanthus are mixed with the dwarf rhododendrons and the fern Osmunda stands erect by the rivulets of water.

The sheep graze on the summer pastures, nomads dig for medicinal roots and the poacher snares the musk deer secure from the attentions of the forest guard. During the winter these uplands are a wilderness of snow, a cold wind blows off the mountains, work ceases in the forest and till the return of spring all is dead.

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And in her left hand riches and honour.
Her ways are ways of pleasantness
And all her paths are peace."

TROWSCOED.

Dr. Gayer, of Munich, was the leader of the reversion to more rational ideas. The general lines of these still hold good to-day. They may be summarised as under—

(1) to conserve and improve the productiveness of the soil by a judicious mixture of species and by maintaining the soil constantly covered,

(2) to obtain regeneration by natural means,

(3) frequent sylvicultural operations,

(4) the cut must remove old and deformed stems and those with small increment in order to increase the volume and value of those remaining.

The confederation gave official support to these principles by its forest enactments of 1874 and subsequently of 1902 and 1903. These represent the very minimum, but cantons may make any additions that they consider to be necessary in the interests of efficient protection. The laws gave to the Federal Government right of supervision of all forest areas.

The enactments are primarily of a protective nature and prescribe the following main principles:—

(1) The total forest area must not be diminished.

(2) Clear-felling is absolutely forbidden in all protection forests, even if of private ownership.

(3) Forced purchase of any rights which exerts an adverse influence on a forest.

(4) Forced but subsidised afforestation and other works of protection against floods, avalanches, landslips.

(5) The financial encouragement of the employment of trained forest officers by groups of commercial or private owners.

This is the present situation but it is of interest to note that these laws were largely called into being by the nature of the ownership and of the forests themselves.

The majority are owned by communes or corporations, the State possessing only 4·5 per cent. and private owners 27·5 per cent. This state of affairs naturally called for considerable control by the State, particularly as 75 per cent. of the forests are classed as protective. All plans of management, if not actually

prepared by a forest officer employed by the State, have to be submitted for approval before being applied. A sound hold is thus maintained on the management of all forests. If communal and private owners do not themselves employ a qualified forest officer they have to be guided by the technical advice of the local State forest officer, who is responsible for all the markings and the execution of the cut. Thus, from the point of view of general management, all forests in Switzerland may be classed together in that all bear the stamp and influence of State control and naturally tend to reflect any national trend of thought concerning sylvicultural problems.

The school of thought, of which Dr. Gayer and subsequently Mr. Biolley were the fountain-heads, gains ground every day. Their whole policy, with regard to sylviculture and forest problems generally, may be described as "a return to nature." It has been aptly said that they alter their theory to fit nature and not nature to fit their theory.

"Il faut faire avec la Nature le plus étroit traité d'alliance... ...Les mèthodes de traitement sont comme les outils inconscients. Le talent de l'ouvrier sera précisement d'adapter chacun d'eux à son champ d'application."

A study of the forests of Switzerland clearly indicated the lines that are being followed in the application of this admirable idea. In no other country at the present time do we find—what to foresters of a few years ago would have been an anathema—the conversion of regular to irregular crops. The Plateau of Switzerland can show some wonderful examples of the periodic system whether practised by groups or by strips or according to the uniform method. These forests consist of very valuable mixtures of broad-leaf and conifer and their growth is greatly favoured by the quality of the soil and the fact that they are not subject to any great rigours of climate. They occupy however a small proportion of the whole forest estate. The majority of forests in Switzerland, however, are of a very different nature and consist mainly of practically pure coniferous woods covering the mountain slopes where the soil is generally poor and shallow and where the growing season is often limited to about four months.

The protective element in the existence of the latter forests is so strong that the selection system would naturally suggest itself as being the most suitable. So firmly, however, does the Swiss forester of to-day believe in this "the method of nature," that a large majority of the forests in the Plateau which are not already under selection forest are being converted or are laid down for conversion. Even in forests still maintained under the system of successive regeneration fellings the period of regeneration is so long that the system is practically a transitory phase between clear-felling and planting and the selection system.

This policy seems strange at first sight when one considers that clear-felling, with all its attendant evils, was preferred to, and substituted for, the selection system on account of the abuses to which the latter was open. This apparent contradiction entirely disappears if one compares the selection system as it was practised —*i.e.*, the removal of all the better trees over a certain diameter limit—with the same system as now carried out entirely under the guidance of purely sylvicultural dictions. It must not be forgotten that the principle of the maximum sustained annual yield holds good for all Swiss public forests. The Swiss forest officers argue that this principle is compatible with the selection system. Their theory is based on the idea that if the regeneration period in the periodic system is considerably lengthened, the increased volume of the mother trees—the so-called "light-increment" —more than compensates for the time lost in obtaining natural regeneration. If this period is grossly exaggerated the forest approaches to selection where full advantage is taken of light and air and also there can be a greater stand for the whole forest as the youngest classes occupy no room. This latter claim is borne out by the fact that the system up-to-date as practised in Switzerland has given greater yields than any other system.

The method as practised is known as the "Method of Control" and the point already emphasised, namely that the method is, *primâ facie*, a natural one, is demonstrated at once when it becomes apparent that the control exercised is based on an accurate knowledge of the real increment and the proportion of the diameter

classes. The essential aim of the Method of Control is to obtain the greatest possible increment per unit of area with smallest possible volume of growing stock.

These are matters of real sylvicultural interest. More details of the method are given below.

It is of more interest here to see what means have been employed for the conversion of regular forest to irregular. These forests are mainly in the Plateau. Pure even-aged crops of spruce are, in nearly all cases, treated by a heavy thinning and subsequent underplanting with beech. It is hoped that natural spruce will come up underneath the beech. Two methods have been applied to the irregularisation of the mixed crops. Both have for immediate objects the freeing of young plants, the removal of excessive volume and of badly formed trees and the breaking up of regular groups : but whereas one method attempts to carry this out by removing single trees, the other favours cutting by groups. The former method has produced admirable and very quick results but the latter, owing to the fact that once a gap has been made it must be opened more and more, is tending to produce even-aged groups, the very state of affairs it is desired to destroy.

The method of obtaining regeneration by groups is comparatively rarely used for conversion to selection forest but it is largely employed for the establishment of the semi-irregular crops obtained under the system of successive regeneration fellings with a very long regeneration period.

The progress of ideas which led up to the introduction of the method of control can be demonstrated very clearly by a scrutiny of the various methods of calculation of the possibility that have been, and in some cases are still, employed.

Management has always been under the control of the canton authorities and each canton has its own forest code. The federation possesses power to amend these instructions. These latter naturally vary considerably with the canton according to the sylvicultural system, its mode of application and whether a protective or a productive policy is dominant. The principle of the highest sustained annual yield holds good for all public forests

and demands an accurate knowledge of the growing stock and of exploitations. The various methods of computing the possibility are briefly set out below. It is instructive to study how they have changed from the rigid method—to which the foresters of the old school attempted to bend nature—to those based on *the actual state of the crop in question.*

(1) Plateau and Jura. Periodic method both by area and volume. This has been found much too rigid and has practically fallen into abeyance.

(2) Heyer's formula has been largely used, but although it allows more latitude than (1) it necessitates the use of yield tables which are rarely applicable to mixed woods.

(3) Mountain forests are principally worked under Von Mantel's formula which has the advantage of simplicity. It is, however, based on a fallacy and is completely artificial in nature.

(4) The Bernoise instructions show the first signs of a break-away from the established methods. They stipulate that the possibility must be based on the current increment which is to be obtained by numerous stem analyses.

(5) The Grisonne instructions are similar but the increment per cent. is obtained by numerous borings.

(6) The Method of Control, which is coming more and more into use, relies entirely on the state of the crop, in particular with regard to the increment and the proportion of the age classes (diameter classes), for determination of the possibility. Both these are obtained from the results of enumerations repeated every 6—10 years; the increment by the difference in volume between two such enumerations allowing for any exploitations that have taken place. These data are obtained for each compartment separately and the possibility is fixed according to the actual state of the compartment. Is the growing stock excessive, deficient, or normal? Shall the cut be more than, less than or exactly the increment? Where shall it take place? There are various points to be considered when solving these questions. The first is the increment per cent.; if this is low it probably means that there is an excess of old over-mature trees with little increment or else

that the growing stock is overcrowded. The proportion of the diameter classes will show where the cut should be made. If it is too high, the forest is understocked. Another point is how far the proportion of "petits bois, moyers and gros bois" depart from the normal 20 per cent., 30 per cent. and 50 per cent. of volume. A third point is the average volume per hectare that experience has shown the forest should carry. The normal growing stock and increment are never definitely fixed and are always treated as merely the results of experience which may be subject to alteration during the next "rotation" as the result of further experience.

It is thus obvious that the compilation of the possibility—calculation it is not—is based entirely on matters as they *are* and not as they should be. It is to this point that forest opinion in Switzerland has arrived.

Will the foresters in those other and larger countries who are just beginning seriously to introduce systematic forest management be able, in years to come, to join their Swiss confrères with equally clear consciences? It must be granted that the method of control as practised in Switzerland is too delicate and complicated a piece of machinery to be applied without simplification but the sound arguments and still sounder results of the Swiss foresters must surely make any forester who places the true value on nature's own methods think very deeply before he discards the selection system in favour of some artificial sylvicultural system.

C. R. R.

[The above essay written by one of our probationers during a visit to the Swiss forests at the end of last year brings out a number of points which are of interest to Indian foresters. The method of control has certain points of resemblance to the Kheri system which has been discussed in these pages but it implies much more imtensive management than has hitherto been considered possible in India while it obviously implies continuity of personal supervision and detailed knowledge of the forest which our staff and organisation does not permit. We have also not yet attained the certainty of obtaining natural regeneration in all circumstances which it involves. There are not a few forest officers in India who consider the uniform method unsuitable and we hope that the essay will provoke a discussion which may in the end be productive of sound practical results.—HON. ED.]

## RATE OF INTEREST IN FOREST INVESTMENTS.

At present in drawing up any valuation of a forest crop one of the first difficulties is to decide on the rate of interest that should be adopted. In pre-war days and in European forests a rate of 3 per cent. was usually accepted. This was in the old days of consols and gilt edged securities. In India some held that the ordinary rate of interest for borrowed money on a good security was higher and that the rate of interest for Forest Investments should be correspondingly higher. No fixed rate has ever been accepted. Each writer who has dealt with the subject of estimating values has fixed his own rate. For purposes of comparison it is essential to fix on one rate of interest and I would propose that a uniform rate of interest might be adopted for the whole of India for Forest valuations. This might suitably be discussed at the Sylvicultural Conference to be held at Dehra Dun towards the end of the year.

With regard to the rate of interest to be fixed I believe this should be about 4 per cent. It may be urged that the general rate of interest on loans has increased very greatly since the war, and it may be questioned whether the rate will ever sink to the pre-war standard. At the same time Forest valuations cover very long periods and should not be unduly influenced by temporary increases in the current rate of interest. In this connection I attach extracts from "Forest Valuation" by Hermann H. Chapman. This book was published in America in 1915 and does not therefore take into consideration the situation caused by the war. It shows however that for Forest valuations spread over a long period the rate of interest should rule low.

H. R. BLANFORD,
*I. F. S.*

Extract from "Forest Valuation" by Hermann H. Chapman, Chapter III, Sections 52 and 53.

52. *The rate of interest in Forest Investments.*—To determine the basic rate of interest applicable to investments in forestry, two factors must be analysed, namely, the relative security of the

investment, and the financial nature of the enterprise. It is claimed by advocates of a high rate on Forest investments that this is justified by the ever present risks from fire and other destructive agencies, and also by the length of the period elapsing between outlay and income, which makes the investment less desirable unless it can be shown to be more profitable.

The first of these claims must be admitted. Risk should be provided against by demanding higher interest. Risks must be judged on the basis of comparison with those assumed in other lines of investment, and due weight must be given to the present development of measures of protection on the part of states and associations.

The second claim is fallacious. To demand a higher rate of interest the longer the returns are deferred is a subversion of the economic laws applicable to all forms of investment. The desirability of the investment as affected by the difference between annual and deferred returns will not modify the rate of interest which should apply, but rather will determine the class of persons who are apt to choose such an investment. And since those persons who are the most apt to favour long-term investments with deferred income are those possessed of foresight, making provision for their children, and with sufficient capital for their personal needs, such persons will accept a lower rather than a higher rate of interest, and in many cases will not even compute the probable rate, being content with the general prospect of a future value greatly in excess of present investment.

53. *Comparison on Interest Rates in Forestry with other Investments.*—Proper rates of forest investments can only be judged on the basis of comparison with other forms of enterprise. If the scope of the comparison is confined to forest production and the account covers the period requisite for growth, a comparison between forestry and business producing annual income is impossible. The goal of forest management is the forest which will yield annual returns, but each crop represents the accumulated outlay throughout its life and must be so judged in comparing interest rates.

The only enterprises familiar to the public, which are reckoned on a basis of compound interest, are savings banks and life insurance companies. The former have paid an average of 3 per cent., but of late years 4 per cent. is common. Most banks do not permit the accumulation of compound interest on accounts to run more than 20 years without some sign of active interest on the part of the owner, manifested either by withdrawals or additional deposits. If the owner is alive and can refrain from depleting his account for fifty years and the bank remains solvent, he can obtain compound interest for that period. Such cases practically never occur.

The average period covered by the risk of a life insurance policy is not over 13½ years, and most companies calculate that they can earn compound interest at about 4 per cent. on the money invested in policies for this average period.

For periods longer than 50 years there is no basis for comparison by which the rates reasonably applicable to the forest investments can be judged, Based upon the economic laws outlined in Articles 47 to 50, it must follow that those rates will be less than 4 per cent. provided the investment offers equal security with life insurance and savings banks. Should the security be considered less safe, the increased rate demanded would offset the reduction in rate called by the length of the period of investment and the investment should not require a rate appreciably higher than 4 per cent. for periods of over 50 years.

If these arguments are admitted, it is possible to show that the income which may actually be earned by forest investments covering long periods will be equivalent to the rates demanded by the character of the investment, even though the earnings may fall as low as 3 per cent. for periods of over 50 years, and 2½ per cent. for periods exceeding 100 years.

## *VITEX PEDUNCULARIS* IN THE TREATMENT OF MALARIA AND BLACKWATER.

An impression prevails in certain quarters that research work at the Forest Research Institute is of too academic a nature to interest very closely an already overworked divisional forest officer.

Now, however, a line of enquiry presents itself which has a personal application to forest officers in addition to its practical professional interest.

In the British Medical Journal of the 5th February 1921, Lt.-Col. J. C. Vaughan, I.M.S., publishes the results of his experiments with an infusion of the leaves of *Vitex peduncularis* var *Roxburghiana* in the treatment of malaria and blackwater fevers.

Lt.-Col. Vaughan having found the efficacy of the leaves of *Aphloia theæformis* (a shrub indigenous in Madagascar) in treating malaria in Bihar and Orissa, set about to find a possible substitute indigenous in India and had his attention directed to the common forest tree *Vitex peduncularis*, whose properties were already known to the Uraons of that province.

The leaves, young shoot bark and root bark are made use of by this tribe but Col. Vaughan appears only to have experimented with the leaves.

So promising do the results seem to be, that enquiries have already been made for supplies of this leaf.

The subject is not so simple as appears at first sight. A good deal more remains to be done than to make a field survey of the species and arrange for the collection of the leaves.

In the first place the active principle has to be isolated and determined. Then comes the question whether the common variety is as valuable as the variety *Roxburghiana*, which is held by some to be only a young form of the main species.

In addition it is important to find out whether the species is equally valuable from all localities and whether there is any seasonal variation in the medicinal value of the leaves.

From the results of other enquiries of this nature it is known that there may be very large local, seasonal and individual

Photo-Mechl. Dept. Thomason College, Roorkee.

Vitex peduncularis, *Wall.*

Photo-Mechl. Dept. Thomason College, Roorkee.

Vitex peduncularis, var. Roxburghiana.

variations in the medicinal value of a plant; witness the *Strychnos Nux-Vomica* of Burma which has now been separated off into a species of its own, *S. Nux-blanda*, a distinction first brought forward by the discovery of the poor amount of strychnine in its fruit.

Similarly in the case of santonin from *Artemeisia*, the drug is completely absent from the plant at certain seasons.

It has happened before now that a product has been turned down owing to neglect in examining these variations before pushing the exploitation of the product.

In the present case the possible importance of *Vitex peduncularis* is so great that it would be an immense pity to spoil its chance by neglect at the start.

It is proposed to examine the product both chemically and botanically at the Forest Research Institute, while the Civil Surgeon, Dehra Dun, has promised to collaborate with clinical tests.

Besides asking for supplies through official channels the President of the Research Institute wishes to enlist the help of all Forest Officers and others in obtaining material for this investigation. He would ask them to send to the Forest Economist consignments of from 10 to 20 lbs. each of the shade dried leaves, young shoot bark or root bark of *Vitex peduncularis* accompanied by botanical specimens wherever possible.

It is not necessary that only the variety *Roxburghiana* be sent, rather the more varieties the better; but to prevent any confusion of the varieties, the produce of each individual tree should be kept in separate packets and referenced to any notes as to the age of the plant, locality, season of collection, etc., accompanying them, which notes will be of very great value to the investigators. Air-tight packets are advisable.

Perhaps some officers will be ready to help in solving the botanical difficulty regarding the variety *Roxburghiana* by marking and recording trees from which specimens have been taken, with a view to following out their subsequent growth.

In conclusion one may add that there is the testimony of one forest officer at least to the efficacy of the remedy for blackwater in his own case.

Two plates are appended to enable officers readily to identify the two varieties.

## LAYS OF THE WESTERN GHATS.

### 1.—NIGHT IN THE FOREST.

The dusty scorching day is past,
The quivering air grows cool at last.
As evening throws its shadows round
The woods awake to many a sound
Where men are scarce and beasts abound.
A swishing noise like fitful breeze—
That is the monkeys in the trees
Jumping about on rustling bambu
Grey-whiskered Pa and smooth-faced Sambu
Now perched aloft, a solemn group
Anon, with chatter and joyous whoop
To safer heights the monkeys troop.
But what stupendous yell is this
That fills the tree-girt wilderness?
A gruesome, whining, lingering howl—
It is the jackal on the prowl
Sniffing the air for carrion foul.
When jaded nerves are on the wrack
No joy to hear the quarrelling pack
Withal they are but vermin creatures
With drooping tails and furtive features,
They yet a certain fear instil,
As louder and higher, harsher still
Those rasping yells the jungle fill.
And later yet a sound more eerie
May raise the hair on foreheads weary,

# EXTRACTS.

## TROPICAL FORESTS.

BY H. N. WHITFORD, YALE SCHOOL OF FORESTRY.

The world contains two great forest belts, the one in the north temperate zone and the other in the tropics. Both are interrupted in their continuity by grass-lands, deserts and oceans. The one to the north, because of its great change of seasons, has but a part time capacity for productivity. It means that Nature's great wood manufacturing laboratory is running only half time. In the tropical belt, midway between the poles, where the wood manufacturing plant runs the year round, capacity to grow timber per unit of area is theoretically twice that of the northern belt.

In past geological ages, due to changes in climate, the torrid zone with its existing forest vegetation has spread toward the poles; at other times the north temperate forests have been pushed toward the equator at the expense of tropical vegetation. It was at the beginning of the glacial epoch that the progenitor of man was supposed to have found himself in a different environment from that of his native tropical forest. He must change his habits or perish. Primitive man was the result. During the whole Pleistocene epoch, with its four distinct glacial and interglacial periods, mankind spread to the four corners of the globe. It is only since the last ice sheet that primitive civilisation arose in Central Asia. It spread to many parts of the globe. In its westward movements it found an environment favourable to its rapid development in western Europe and later, North America, and what we call modern civilisation came into being.

In the spread of primitive civilisation it has encountered certain natural obstacles in its way. These are the desert, the mountains, the forest, the sea, and the rigours of winter. It was the overcoming of these obstacles that increased man's brain power and has resulted in our modern civilisation.

In this struggle the forests, at first an obstacle, have played no small part. Their products furnished firewood for cooking purposes and timber to build houses and minimised the rigours of winter. They supplied the materials that built the ships that conquered the seas, the highways of the world. One need not enumerate the thousands of uses to which forest products to-day are put. In spite of the many substitutes for wood per capita consumption is increasing. Naturally the forests nearest at hand, or those of the north temperate zone, are the ones that have been most drawn on. Each successive virgin forest has been attacked, destroyed, or badly damaged and the operations transferred to another place. In western Europe the virgin forest has disappeared. Planted or well managed second growth forests have taken their place. In the United States of the original 820 millions of acres on which nature's chemical wood factory had produced stocks of timber ready for the axe, but 463 million acres are left. Of this amount 137 million acres or one-sixth of the original area is virgin forest, 80 million acres is unproductive waste. More than half of the remainder is small timber of inferior quality.

Nature's wood chemical laboratory needs to be protected against the further ravages of man. It has been so badly damaged that it will take many years for its recovery. Especially is this true in the eastern part of the United States where there is a shortage of wood already. Even if the severe measures advocated by the most radical forest economists were put in effect to-morrow, it would be many years before timber could be utilised. Certain of our industries, some of them basic, that depend in part or wholly upon forest products, are feeling the shortage of raw materials. The average citizen feels it in the much higher prices he has to pay for everything made of wood.

It is known that the vast areas in the tropics are covered with forests. Do these forests contain wood products that will aid materially in the further development of our modern industrial civilisation? This question has been answered pro and con. But the answer either way has not been satisfactory because much investigation is necessary before the truth can be known.

It is true that the wood products of the tropics have played only a very small part in our economic life of to-day. Statistics for 1913 show that not much more than 150 million board-feet reached the United States from tropical countries. More than half is classified as mahogany and Spanish cedar, and much of the remainder are cabinet woods of various kinds. On the other hand, until recently the northern belt of forest ships annually more than ten times this amount or number, mostly construction timbers, to tropical countries. There is no tropical country that has an industrial development worthy of the name, but has been the recipient of the products of our forests. This has led some forest economists to the belief that tropical forests contain nothing but hard, heavy woods suitable only for cabinet work or furniture manufacture or for other special uses that do not need large quantities of timber. Where investigations have been made, as in the Philippines and British North Borneo, this has been proven not to be the case. On the other hand, these investigations show the forests are more abundantly supplied with soft hardwoods that can and are being substituted for the same uses to which the pines and oaks were formerly put. It has been estimated that in the Indo-Malay region there are about 1,600 billion feet of standing timber ready for the axe, or about the estimated amount that is contained in our Pacific North-West.

The area of standing timber in the Amazon Valley is estimated to be over one billion acres, or more than twice the forested area of the United States. Before the writer had seen the forests of the coastal region of Dutch Guiana and the coastal region of Brazil, he estimated the stand of timber in the Amazon Valley to be 3,400 billion feet or 600 billion feet more than is contained in the United States. He now believes that estimate is too low and that the figures given are ultra conservative. In tropical America besides the Amazon region in Brazil, in the Guianas, Columbia, Venezuela, Central America, Southern Mexico and in Paraguay and neighbouring parts of northern Argentina there are large areas of forests. The Belgian Congo region alone is estimated to contain 448 million acres of forests of one kind or another. With the

exception of a comparatively few woods that reach our markets and those of Europe, usually the gold nuggets of the forest, we know little about the capacity of these forests to produce timber for the more general use of industrial civilisation.

One of the first steps to gain the required information is a knowledge of the forest flora of these regions. Much progress has been made in the classification of the forest flora in the colonial possessions of the United States and European nations. Specially is this true of India and the Philippines, the Dutch East Indies, some colonial possessions of Africa and elsewhere. Some progress has been made in tropical America. The first fascicle of a publication entitled "The Trees and Shrubs of Mexico" has recently been published. The West Indies and parts of Central America have been fairly well combed in a general botanical way. Recently a combination of three of our largest herbaria has undertaken to direct its attention to Northern South America. Our herbaria contain much material that needs to be worked up, but the corps of trained men is far from being adequate. The systematic botanists of our country should be encouraged in every way possible to continue the work already begun.

While systematic work is necessary for an understanding of the composition of the forest, yet this is only a classification of the forest, composition from a qualitative stand-point. A quantitative as well as a qualitative analysis of the forest is necessary to know its economic value. Because we have depended on the former rather than the latter studies of tropical forests, a widespread misconception of their nature and economic importance is current. It is interesting to know that in the Philippines there have already been classified 2,600 tree species in an area of 120,000 square miles, or about three times as many as are found in the whole of the United States, distributed over an area of more than three million square miles. Yet from an economical standpoint it is much more important to know that more than one-half the standing timber of the Philippines is composed of less than 20 species and that when the lumber of these is put on the market for general use they fall into three groups, one a

group of hard durable timbers for construction work in contact with the ground, another, moderately hard non-durable timbers for heavy construction work not in contact with the ground, and a third group, by far the most abundant, composed of comparatively soft non-durable timbers that are being used for light construction work. It is true that sometimes the wood of a particular species of any one of these groups is preferred for special uses. Before it can be stated that similar conditions exist in the virgin forests of the American and African tropics more extensive studies are necessary. Indications point to the fact that the composition of the upper story or two upper stories of the forest, and these are the stories that contain trees of merchantable size, are more complex than those of the Philippines, but much simpler than a census of the trees of all the stories of a given tract would show. Thus, published accounts of a census of forests made in British Guiana show that in one type of forests covering large areas three species formed 45·7 per cent. of the trees; 7 species, 61 per cent. In another type one genus and two species formed 42·8 per cent. of all the trees. Still other types showed similar conditions. These studies were based on counts by diameters and not by volumes. Had an estimate been made by volume it is believed that the percentage of the leading species would have been higher. The writer has had an opportunity to make detailed studies for limited areas in the American tropics. In one case 90 per cent. of the timber of merchantable size was of one species, a hard, heavy wood suitable for ties. This was in a dry region and the amount per acre was light. In another region in one type 100 per cent. of the timber reaching merchantable size was of one species—a soft hard-wood. On the property examined there were 8,000 acres in this type and the stand wood average 25,000 board-feet to the acre, in some places 60,000 to 70,000. This is exceptional, however. In an adjoining type, which because of lack of time was not studied in detail, perhaps eight or ten species would yield 60 or 70 per cent. of the cut with the stand per acre much lower. Cursory examinations in other parts of the American

tropics show conditions similar to the last. These examinations are not extensive enough to make general conclusions.

The above is given to show the necessity of investigation. Expeditions to carry on the work could well be confined for the present to the more accessible areas. The personnel composing them should be equipped to collect botanical material including wood samples, to map the areas covered and roughly estimate the amount of timber by kinds. Especial attention should be paid to the woods known in the local markets and to those species that are most abundant whether or not they are known to be of use. All forest products other than woods should be studied and samples collected.

Another line of investigative work is the classification of woods. Good work has been done on the woods of India, the Philippines, Java and other colonial possessions in the tropics While some progress has been made in the American tropics, the field for study has hardly been touched. One institution in the United States has undertaken this work, but because of lack of financial support the progress is slow. The importance of this work will become apparent when it is stated that there are numerous requests for identification of tropical woods that have entered our markets. There are requests also for information concerning tropical substitutes for many of our own woods that certain industries depend upon. These requests are made because such industries are getting anxious about the future source of supplies.

While our modern industrial civilisation has depended on the tropics for its woods *de luxe* only and has furnished their people with a considerable supply of their construction timbers, it has gone to tropical forests for other classes of products that have become indispensable to some of its basic industries. Aided by the increased energy of the tropical sun, nature's chemical laboratory is able to produce, besides wood, a greater abundance of certain by-products than is possible for its less energetic competitor in temperate climates to do.

Thus modern civilisation to-day is depending on the tropics for rubber and its allies gutta-percha, balata and chicle. Resin-

like substances, oils, dye woods and tannin products play an important part in our arts and sciences.

The products of tropical palms play an important part in our everyday life. The soap with which we take our bath may contain palm oil. We may put on a coat that has buttons made of the nuts of the ivory palm. The hat we wear may be made of the fibres of the Panama palm. Some ingredients of the explosives we used to help to win the war may have come from a palm, and the best charcoal used in the gas masks that protected our men on the battle-field may have been obtained from the shells of several species of palm nuts. The candles we burn may be made of the wax taken from the leaf of a palm. The rattan chairs we sit on and the canes we carry may have come from climbing palms that grow in a tropical forest. The mattress we sleep on may be made of kapoc, the products of the fruit of the silk cotton tree. *We are dependent on the tropics for such important* medicines as quinine, ipecac, and a host of others used in pharmaceutical science.

Only a few of the hundreds of different kinds of products, which the people that live in or near tropical forests make use of in their daily lives, reach our markets. Many do not reach the local markets. As they are better known they may become an article of local trade and then ultimately reach the world's markets. The history of the discovery of many of the products and their introduction into our markets reads like a romance.

Most of the raw materials from which the articles cited above are made are still gathered in virgin forests. One by one as the articles become more essential to our modern civilisation, experiments are made to test the possibilities of their being raised profitably as cultivated crops. Take the case of Para rubber for instance. In its native home, the Amazon River, the trees grow far apart and the cost of collecting is great. Our knowledge of the existence of rubber dates back to the discovery of America by Columbus, who is said to have seen natives playing with rubber balls in the island of Haiti. It was first used, long after, to remove pencil marks. Later the Mackintosh firm began to

manufacture waterproof coats, but it was not until after 1839 when Goodyear discovered the process of vulcanising it, that the Mackintosh waterproof coats came into moreg eneral use. The British Government, ever keen to get valuable products growing under its own flag, encouraged its introduction into Ceylon in 1876 and cuttings from these plants were distributed to other parts of the British Empire throughout the tropics. It was not however until the first decade of this century when the automobile industry began to demand large quantities that commercial plantations were established. In 1910 the world's production of rubber was 68,200 tons, 12 per cent. from plantation rubber. In 1920 it is estimated to be over 3,00,000 tons, 90 per cent. of which is from planted rubber and most of this from the Federated Malay States and neighbouring regions, one of which is Sumatra. It is here that American capital has made its investments under Dutch control. While much investigation has been made in increasing the productivity of rubber trees in plantations, research problems in the management of the cultural forests to give maximum results are still in progress.

Of importance to us as a nation is the possibility of extending the growing of Para rubber nearer home. Plantations in various parts of the American tropics exist but so far generally have not been successful. Investigation work here is of prime necessity. It involves research work in the methods of protection against a disease that is present only in the American tropics.

Because of political control and economic conditions connected with supplies of labour, European nations have introduced other forest products, whose native home is in the American tropics, into their eastern colonies. Among these are the cultivation of Cinchona tree (quinine) and the silk cotton tree (kapoc). Thus to-day Java produces most of our quinine and nearly all the kapoc.

The writer cannot leave the subject of Tropical Forests without a word concerning the possibilities of the tropics for growing crops of trees for their timber and its by-products such as cellulose. In the production of wood supplies, the English in

British India and to a less extent the Dutch in Java have made advances. The British, not content with managing their valuable natural forests which contain teak to yield continuous supplies of timber, have planted large areas which are yielding returns. The Dutch also have extensive forest areas planted in teak. Experiments in teak planting are under way in other British tropical colonies in Trinidad and West Africa especially. This includes experimental plantations of such valuable woods as mahogany and Spanish cedar and others.

While much research in rapidity of growth of planted tropical trees and other plants has been made, and indicate that crops of timber will reach maturity in a much shorter time than in our own climate, much investigation is necessary before the exact time it will take to raise such crops on a commercial scale can be determined. That there is great variation in the rapidity of growth according to the species and to the nature of the habitat is true for the tropics as well as for temperate regions. Measurements made recently in virgin forests of the Philippines indicate that the annual increment per year is 1·91 per cent. of the mature stand. It has been estimated that the annual growth in our southern pine forests is one per cent. of the mature stock in hand. If these estimates are correct it means that the tropical sun has annually somewhere near twice the capacity to store up energy in the form of wood, than does the temperate sun. To put it in another way, one acre of ground can grow as much timber in a year in the tropics as two acres in the colder climate.

The above-mentioned estimates were made in the dense forest and show that the large trees have a much more retarded growth in their younger stages than do many of our own species in our climate. It is only when they reach the middle and upper layers of the forest that they overtake and pass in rapidity in growth many of our own species. Estimates in growth on the same species in the forest and in the open show that in the forest it takes about twice as long to reach a diameter of 12 inches as it does in the open.

The same investigator made measurements in the second growth forests and compared them with the average growth of

a large number of species in the United States. This shows that it takes our species an average of 68 years to reach a diameter of 14 inches, whereas the Philippine species measured reached the same diameter in 17 years. According to recent investigations made by Dr. Rowlee in the rich bottom fruit lands of Central America, crops of timber of balsa wood averaging 20,000 board-feet per acre can be raised in five years. In the Mississippi Valley, it takes cotton-wood, our fastest growing hard-wood, 30 years to yield the same amount of lumber. The above examples are given because the forests of the tropics contain many soft wood species whose specific gravity is about that of spruce and white pine. Some of these occur in pure or almost pure stands on cut-over lands and reach maturity in 15 or 20 years. Others occur in virgin forests, and in certain habitats constitute the bulk of the stands, in one case at least, all of the stand over limited areas. They reach huge dimensions, six feet and over in diameter, 150 to 200 feet in height. The indications are that they attain maturity in 75 to 100 years or less.

If investigation should show that one or more of the many kinds should prove suitable for paper-pulp, crops of timber could be raised in one-fourth to one-third the time that it takes to produce a similar crop of spruce in our temperate regions.

In the above there has been an attempt to bring together a few of the facts concerning tropical forests, the extent to which they are used, and their rate of growth. Our knowledge concerning the possible uses to which many of their products could be put is limited. Much pioneer investigation along the lines suggested above is needed before we can answer many questions. The tropical sun has stored up energy in the form of wood and other products that are to-day little used. It is shown that it has the power per unit of area to produce annually two or more times as much of this form of energy as the temperate sun. Modern civilisation has used a great deal of this form of energy to aid its development. Believing it had unlimited supplies it has wasted more than it has used and is now making strenuous efforts to conserve the remaining supplies nearest at hand. This is good

economic common sense and every effort possible should be made to encourage the better conservation of our forests, but the damage has been so great that long before we can bring them back to proper management, many of our industries will suffer. Our nearest source of outside supplies is the American tropics. Hence the need of investigations along the lines suggested above.

The economic conditions associated with the exploitation and cultivation of tropical forest products are admittedly not the best. The people of our modern civilisation have a fear of the tropics. Their Simian ancestors were held in bondage by them until climatic changes forced them to change their habits. Modern civilisation in its development has brought under control many of the forces of nature of the temperate regions of the world. It is only when it felt the need of products which it could not find near at hand than it has gone into the tropics.

After all, the danger of the tropics is not so much in the climate as such, but in the diseases that it breeds. The sanitation work done in the building of the Panama Canal alone proves this. There have been many other less advertised cleaning-up operations on not so large a scale that strengthen the proof. Witness the work done by colonial governments in sanitation, the Americans in the Philippine Islands, the British and Dutch in many parts of the tropical world. Very significant is the work accomplished under the Brazilian government in making sanitary the principal cities that were subject to serious outbreaks of yellow fever and other diseases. Many private concerns, realising that success on a large scale could not be obtained, have their physicians and sanitary engineers. The Rockefeller Foundation has undertaken the task of making yellow fever a historical disease and has done much work in many parts of the tropics in controlling other diseases such as malaria and the hook-worm. This work shows conclusively that nature's forces in the tropics can be controlled, and the day is at hand when the economic resources of the forests can be more fully utilised to serve our increasing wants.—[*Scientific American Monthly* March 1921.]

## INDIAN TIMBERS.

### GROWING USE IN BUILDINGS IN THIS COUNTRY.

The April number of the *Asiatic Review* contains an interesting article on the commercial prospects of Indian woods in this country. It is stated that the more important building contractors are taking up these valuable woods seriously and several examples are given of their use. The article recalls that about nine months ago an Empire Timber Exhibition was held under the auspices of the Overseas Trade Department of the Board of Trade. The Government of India and their adviser realised that this was a good opportunity to introduce some of the more decorative Indian timbers, and what was possibly the most comprehensive collection of furniture, panelling, flooring, and so forth in Indian woods which has ever been seen was there exhibited.

A considerable amount of work is now being done at the new County Hall, Westminster, in laurel wood. Laurel, silver grey wood, padouk, and gurjun wood are being used in a building in Eastcheap. The new offices of the General Electric Company in Birmingham are being panelled, fitted, and finished throughout in Indian silver grey wood. Laurel wood and gurjun wood are being used in the new offices of the Guardian Assurance Company, opposite the Monument Station. A large portion of the flooring of Messrs. William Vernon and Sons' new factory at Silvertown is of gurjun wood. The new board-room for Messrs. Bovis, Ltd., in Upper Berkeley Street was entirely panelled and furnished in padouk. Laurel wood and padouk are being employed by the Bank of England for fitments.—[*The Times Trade Supplement*, April 23rd, 1921.]

# REVIEWS.

## A SHORT MANUAL OF FOREST MANAGEMENT.

BY H. JACKSON, M.A.

Of the making of books on forestry there appears to be no end. The present volume sets out to simplify existing text-books on the subject, an object which has largely been achieved by cutting out a lot of useful information which it is generally considered essential for a text-book to contain. For instance Chapter VII gives no other method of calculating the yield of a selection forest than the Indian one based on the numbers of trees of different diameter classes and the number of years taken by a tree to pass from one diameter class to another. Now this method as stated by Recknagel lacks elasticity, is complex and liable to error and requires as much data as better methods. With a long personal acquaintance with marking fellings in a selection forest we are convinced that this method of calculating the yield is altogether opposed to good sylviculture and reduces the work to a monotonous removal of I class trees which leads nowhere. We are pleased to see that this method has altogether been discarded in one of the latest working plans and that the yield cf a selection forest has been calculated in volume by Hufnagl's method on a complete enumeration of the growing stock. In this way proper thinnings will be made and whatever size trees should come out will count against the prescribed yield. The present volume describes the theoretic selection forest which can only exist in the case of a dense shade bearer, it hardly does justice to the many manipulations this system is capable of to suit the varying light requirements of different species, and we cannot agree with the author that in such forests tending operations are of less importance than in even-aged crops. The selection forest has a bad name but still in certain circumstances it is the only system and under it the art of sylviculture probably reaches its highest point.

Chapter II is not too clear for a student in several particulars, for instance normal volume merely refers to quantity and has nothing to do with a normal succession of age classes. Normal volume may be present altogether apart from any normal distribution of the age classes.

The author is at his best in describing the field work in Chapter IV, the general principles of working plans Chapter V and the methods of treatment Chapter VI, and we cannot help thinking that he is more at home in these subjects than in the previous pages of the book. We have no hesitation in quoting the author's remarks on the number of standards, their relations to coppice and the proportion of the canopy occupied by them with which we are in entire agreement and commend it to Indian foresters dealing with such woods.

"Now if the main object of the reservation of the standards be to protect the underwood from exposure and to supply seed, and the underwood is to be looked upon as the more important of the two kinds of crop, then the number of standards should be fixed so as just to effect these cultural objects, and should be kept at a minimum. The number should be no greater than what would ordinarily be sufficient for these purposes. But if, on the other hand, the object of maintaining an overwood is to produce timber, then in this case the value and importance of the standards will far outweigh that of the underwood, and the interest of the owner will demand the largest number of standards possible, without impairing the vigour of the coppice, which will still be the main agent of the perpetuation of the forest. These principles will be sufficient to enable us to decide on the number of standards to keep. The upper limit, that is, the maximum possible number of standards is fixed by the fact that if the overwood forms a close canopy, the underwood will languish and tend to disappear. The rule therefore is that the standards must never be so numerous that each tree is not in a state of complete isolation, even at the end of the rotation, just before the felling is made. As soon as the crowns of the standards begin to touch one another, the coppice is in danger.

"It will not be necessary each time to make a calculation as to the superficial cover of each size of reserved tree. As a general rule the standards will stand over one-quarter, or as a maximum, one-third of the area, and local experience will generally be available to assist one in deciding on the right number of standards per acre."

We do not consider that the form of working plan report given in Chapter VIII is suitable to conditions in Britain and would have liked to see the subject of British estate forestry considerably extended. The book may serve some purpose in teaching the rudiments of forestry, but the student will require a much more detailed knowledge of the subject before he can be considered proficient, and the practical forester will find little in the book with which he is not already acquainted.

## TAUNGYA CULTIVATION AS APPLIED TO FORESTRY.

On page 232 of the *Scientific American* for March 19th, 1921, appears an interesting article on what is known in India as 'Taungya' cultivation as applied to forestry. The land is ploughed with a 14″—20″ furrow slice, which is completely turned over, not set on edge as is usual in British agricultural practice. The land is then limed and possibly some phosphatic manure such as basic slag, applied and harrowed in. Yellow lupins are sown in May and ploughed in when in full flower, to be followed by a winter corn crop. Sometimes a second corn crop follows and the one year old conifers are planted in the corn from December onwards. Owing to their small size they are said to escape damage at harvest time but with a close cutting reaper it is difficult to see how this is so. Attempts have been made in the Himalayas to grow *Pinus excelsa* by sowing it with a crop of wheat on old cultivation but were not very successful. Taungya cultivation of forest crops is of course well known in India and has been adopted on a large scale in both Burma and Bengal with excellent results. The principles of 'preculture' as the article calls it are those applied to the afforestation of the ravine lands of Etawah, where attempts are being made to grow a cotton

crop between the lines of seedlings. This would certainly have been successful last year if an almost entire failure of the rains had not occurred.

A scheme for the ploughing of the extensive grass-lands of Kheri by steam tackle preparatory to afforestation is in hand and it is hoped to recover a considerable part of the costs of cultivation by intercropping with sun-hemp. The use of such a tackle presupposes land clear of stumps but might be quite suitable for breaking up land for the Punjab irrigated plantations; and even in Bengal, if the standing forest crop was uprooted instead of being felled, such machines could be employed.

It should be emphasised however that taungya cultivation can only be considered on comparatively flat land and that in the case of sal the absence of frost is almost essential to success. Finally it should be remembered that some forest soils are of such a poor stony nature as to be almost incapable of producing any agricultural crop. In the case of the heath lands of Britain it is difficult to see how much of the costs of cultivation can be recovered by the value of the crop. Most of this land is too high for wheat and even at 95 shillings a quarter the growing of wheat nowadays is hardly a paying proposition.

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# INDIAN FORESTER

*AUGUST, 1921.*

## SOME NOTES ON FOREST INSECT PESTS IN BURMA.

While I was in Prome Division, in several successive years I noticed that defoliation was very bad in many of the teak plantations; in Tharrawaddy, a Yemane (*Gmelina arborea*) plantation, only two or three years old, was similarly defoliated in the year in which I saw it. It has struck me that one is rather inclined to pass the matter off as unimportant, so I worked out figures, founded on estimates which I think are well within the mark.

Defoliation of teak plantations is usually due to one or both of two insects, *Hyblæa puera* and *Pyrausta machæralis*. In Prome, the attack usually commences as soon as the leaves appear, and by the end of June, I have seen whole plantations leafless; at the end of August, a fresh crop of leaves usually appears. Teak is normally in leaf from the beginning of June to the middle or end of January, say a growing season of eight or nine months;

of these early defoliation of the type mentioned above robs it of the three in which growth is most vigorous, and in addition causes the strain entailed by putting out a second crop of leaves. So far as I know, no measurements have yet been taken to show the actual loss of increment involved; I have felled trees in attacked and unattacked plantations, and the growth ring was decidedly smaller in the former. But such isolated notes of experiments, carried out hastily with heavy other work on hand, cannot give reliable data. I do not think many will quarrel with me if I estimate the loss of increment involved, combined with the loss of quality due to small and irregular annual rings as half the money increment for the year. It has been noted elsewhere that in the case of an attack commencing later in the year, and of rather longer duration, the leading shoots were killed, and one or more of the side shoots carried on as leading shoots; this would cause further loss of quality, and a corresponding further loss of money increment.

Assuming, then, that at least half the normal increment is lost in years when defoliation occurs, the next point is the method by which the loss is to be calculated. Two ways suggest themselves, either by taking a proportion only of the volume or value which would normally have been attained had the plantation not been attacked, or by lengthening the rotation, so that the same volume may be reached as in an unattacked plantation in the shorter period. In future we shall probably be endeavouring to grow trees of a certain size, and therefore the rotation adopted will be that necessary to produce such a size; if say 10 years' increment is lost, the rotation will have to be lengthened by 10 years to make up for it.

Figures for normal plantations have been taken from the "Financial possibilities of even-aged crops in Burma," by H. R. Blanford, *Indian Forester*, February 1920, to which a reference is invited. He first takes teak with a rotation of 120 years; if defoliation takes place in 20 of these only, an incidence which I consider much below the actual, the loss of *half a year's increment* in each year of attack would cause a total loss of 10 years'

increment in the rotation or 1/12 of the total volume. This would give us :—

| | | *Nett return.* | *Ground value.* | *Ground rent.* | |
|---|---|---|---|---|---|
| Normal | ... | 5,273 | 156 | 4·68 | @ 3 % |
| 11/12 of above | | 4,833 | 143 | 4·29 | |
| Loss | ... | 440 | 13 | ·39 | |
| Normal | ... | 4,901 | 25 | 1·125 | @ 4½ % |
| 11/12 of above | | 4,493 | 23 | 1·031 | |
| Loss | ... | 408 | 2 | ·094 | |

The loss at 3 per cent. is Re. 0-6-3, at 4½ per cent. Re. 0-1-6 per acre per annum. The Burma Forest Administration Report for 1919 gives in Imperial Form 18, page 152, a grand total of plantations in Burma of 97,336 acres. I have taken 100,000 acres as being the figure to-day. The plantations are not all teak, but the financial results from low priced, quick growing timber may be as good, if not better than those from teak. This figure gives a nett annual loss for the province of Rs. 39,000 at 3 per cent. or Rs. 9,400 at 4½ per cent., a sum growing in proportion as the area under plantations increases.

Working out the loss by the second, and I think more correct method, that is taking the rotation necessary to produce similar timber as being the normal rotation, plus the time lost, or 120 + 10 years, and assuming the nett return to be the same in both cases, we get :—

| | | *Ground value.* | *Ground rent.* | |
|---|---|---|---|---|
| 120 years | ... | 156 | 4·68 | At 3% nett return 5,273. |
| 130 „ | ... | 116 | 3·48 | |
| Loss | ... | 40 | 1·20 | |
| 120 years | .. | 25 | 1·125 | At 4½ % nett return 4,901. |
| 130 „ | ... | 16 | ·720 | |
| Loss | ... | 9 | ·405 | |

That is, the annual loss for the province, at 3 per cent. is Rs. 1,20,000, and at 4½ per cent. Rs. 40,500. A further point is that, especially at the higher rate of interest, ground value and rent have been reduced to a point at which they compare

unfavourably with returns derived from other methods of using the land.

I think it is now generally conceded that so long a rotation as 120 years will not be required; if we take Mr. Blanford's figures for Nilambur teak with a 75 year rotation, and assume 10 years' defoliation only out of 75, since this rotation will only just supply trees of the size required by the market, we cannot allow for a loss of 1/15 of the nett return, but must increase the rotation to 80 years. This gives:—

| | | Ground value. | Ground rent. | |
|---|---|---|---|---|
| 75 years | ... | 504 | 15·12 | At 3 °/₀ nett return 4,117. |
| 80 " | ... | 427 | 12·81 | |
| Loss | ... | 77 | 2·31 | |
| 75 years | ... | 168 | 7·56 | At 4½ °/₀ nett return 4,398. |
| 80 " | ... | 134 | 6·03 | |
| Loss | ... | 34 | 1·53 | |

The above figures are sufficient to show that defoliation causes very considerable annual financial loss; a fair estimate for existing plantations is probably Rs. 1½ lakhs per annum, a figure which excludes loss due to damage done to trees in natural forest.

A more widely known pest than these defoliators is the Teak Bee-hole borer, *Duomitus ceramicus*. As I understand that there is a note by Mr. Beeson on this beast in the Press, I will say no more than that it has entirely ruined some plantations, and damaged others badly, while teak from ordinary girdlings may be enormously depreciated in value as the result of its attentions. Estimates of the damage done vary from Rs. 10 lakhs to Rs. 1 crore *per annum*. It is quite possible that detailed examination will show that even the higher figure is well within the mark.* The fact to which I wish to call attention is that it is undoubtedly worse in many if not all plantations than in the surrounding jungle, or

*NOTE.—"Damage" means depreciation in value, and appears both as loss of revenue to Government, and loss of profit to the lessees. The rates in a forest known to be badly infested will be lower than they would have been had it been clear of the pest. A badly bee-holed log is often fit for nothing but firewood and bad firewood at that.

than it was in the jungle which was on the ground before the plantations were made.

Both cases, the bee-hole borer and defoliators, are simply further examples of the fact that plantations, especially pure plantations, by the increased facilities given for propagation are specially liable to cause enormous increases in the damage done by pests, which may even be comparatively harmless in the old mixed woods.

An examination of some of the things which we do in making a plantation may yield useful information.

*We replace mixed woods with woods of one species, or at* any rate containing one species in a vastly greater proportion than it existed in the old wood.

We remove a wood, containing a large number of hollow trees, and trees with small holes and hollows in them, and generally a fair amount of scrub on the ground, and replace it with one of small trees, at first, and later of even-aged trees, allowing generally little scrub on the ground, and from which trees showing signs of holes or hollows are the first to be removed in thinnings.

Under natural conditions, under which any given insect has not reached the stage of being a pest, a balance must have been struck and maintained. If conditions were such that the insect became a pest continuously, the food tree would cease to exist. If the enemies of the insect were too numerous, the insect ceased to exist. (I am excluding the case of imported beasts which have turned into pests.) Therefore we may assume that before plantations were started by us, any given insect, its food tree, and its enemies were balanced. By introducing pure woods, we increase the propagation facilities of the insect, while by removing all the hollow and holey trees, we take away the propagation facilities of such animals as use them. A very large factor in keeping down insects is birds. Those which are likely to do most good are woodpeckers, nuthatches, tree-creepers and tits. All of these breed in holes in trees, and are most active when they have young to feed, that is in May, June, July. Woodpeckers make holes to extract larvæ, the other three kinds search

every crack and cranny in a tree for free-living larvæ, and eggs. I have watched a pair of nuthatches, with a nest containing 5 young ones, and during the time I was watching them one parent or the other returned on an average every 4 minutes with sometimes as many as 7 on 8 larvæ in its beak. They are birds with weak powers of flight, and allowing for the time necessary to find the larvæ, I do not think they can have gone more than 100 yards, certainly notmore than 200 yards from the nest. The young stay in the nest a month or six weeks, after which, for another month at least the family hunts together, and does not go very far from the nest. Assuming one of the parent birds to return to the nest every 5 minutes, for 12 hours a day, carrying only 5 larvæ, we get $12 \times 12 \times 5 = 720$ larvæ a day, that is 21,600 in a month, apart from what the parents themselves eat. I think 25,000 larvæ a month is a low estimate for a family of birds of the size of nuthatches or tits.* In addition, they must destroy an enormous number of eggs.

Hatching and dispersion of most larvæ takes place just at the time when these small birds are hardest put to it to supply their families, and their activities are confined to an area about say 300 yards square, or about 20 acres. The area of say 5 acres just round the nest is probably entirely cleared of larvæ, the intensity of the clearance becoming less the farther one gets from the nest.

The case of woodpeckers is somewhat different; they collect part of their food from the surface of the bark, but most of it from just underneath it, or from within the tree itself. Because they damage the tree to some extent in getting it, they are a less satisfactory form of protective agent than tits, etc. But they get the larvæ out when tits could not do so, and I consider that, as damage had already been done to the tree, the good they do by killing the larvæ, and so preventing them from propagating their species outweighs the harm done to an already damaged tree. I believe, except to make a nest, they do not make holes unless there is an insect at the end.

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*NOTE.—This may sound a very large number: growing birds eat their own weight, or a little more, of food daily.

As noted above, all these birds nest in holes. Many other birds (Magpie robins, laughing thrushes, warblers, white-eyes, to name a few only of those feeding on insects) nest either in undergrowth, or cracks and crannies in stumps and old trees, rubbish on the ground, etc. When we make a plantation, and maintain it properly, there is in it little scrub or rubbish, and practically no stumps, or trees containing holes. That is to say, we have removed a very large proportion of the available nesting sites for one kind of natural enemy of all insects. We go further: In girdling an area we remove as far as possible hollow trees, and those with holes in them ; a large number of birds seem to nest in teak trees, possibly because most other trees rot too quickly to produce a very suitable kind of hole. So apart from the restricted area of plantations, we have removed a large number of nesting sites from the jungles round them.

One solution of the question of insect pests arrived at in Germany was to hang up nesting boxes round and in plantations ; that is, short pieces of branches, or poles, bored out with an expanding drill to imitate the natural nest holes of the birds as nearly as possible. The matter was very thoroughly dealt with, *more germanico*, in Von Berlepsch's Erlaüterung über der Vogelschutzfrage. I have mislaid my copy of this book, and speak from memory, but I think I remember that an entrance hole 32 millimeters in diameter admitted sparrows which kept out tits, while one of 27 mm. admitted tits only. The nest boxes varied in size, up to one for large owls (an insurance against mice), while many details were found to be important, *e.g.*, the direction in which the entrance hole faced (to keep out rain); the roughing, or ridging of the inner walls, to help the bird in and out; the removal of all roughnesses and splinters from the bottom of the hole, as they cracked the eggs ; putting in a certain modicum of saw-dust, as a bed ; the tilt of the box, so that rain ran out of the entrance hole instead of into the nest. Many other things were also dealt with; open nest boxes, and thick hedges of carefully pollarded bushes for birds which use them, and food and water-supply during the winter, for which complicated, but apparently efficacious

arrangements were made. When I was in Germany, I think one box used to be held to police about 10 acres in normal years, but this area was decreased if there were any signs of insects becoming numerous in neighbouring districts. There were certainly cases in which forests protected in this way were untouched, while neighbouring districts were badly attacked. I think the question deserves looking into in this country; I have myself had boxes put up in three places in 1920, but the conditions under which the experiments were carried out were very bad, and I could not look after it myself, as I was on leave. All that can be said was that about 40 per cent. of the boxes put up were filled within a month and that in at least one case there was said to be a decided decrease in defoliation, which had been bad in the previous 4 or 5 years. Other things which might be useful out here are the provision (or leaving) at corners of plantations of patches of thick scrub (say ¼ acre in extent), and water in the hot weather; while certainly birds such as night jars should be protected, as they catch the imago in flight

A second result of removing all hollow trees is that bats and lizards are deprived of their homes, and have to move elsewhere. Lizards catch moths, etc., in the daytime, while bats (and night jars) catch them in flight at night. I believe it is in Cuba that the establishment of roosting sheds for bats has exterminated mosquitoes, so this also seems to be a line worth trying.

Most of the methods in use in concentrated areas like fruit gardens, such as ringing with tar, spraying, etc., involve a tree-to-tree inspection impracticable in forestry. There is one, however, which may be applicable: large breeding houses are kept where enormous numbers of the larvæ of the pest are bred: every one is infected with parasites, in the cage, and these are bred out, and set loose in enormous numbers. This is said to make an appreciable difference in fruit gardens, and might be practicable, *e.g.*, in plantations badly attacked by defoliators.

The effect of fire is another question which requires investigation; the increase in pests, or the observation of the alleged increase in pests, occurs after a period of rigid fire-protection.

Early light burning may possibly not destroy pupæ (buried or otherwise) to the same extent as natural late heavy fires.

As pointed out above, the damage due to defoliation alone is estimated, for the plantations in Burma, at 1½ lakhs per annum.

In pre-war times in Germany, nest boxes cost about 65 to 70 pfennigs each—say 8 annas. I gave some made of oak to the London Zoo in 1911 which were still in use in 1920; teak, or possibly a softer wood treated with some preservative, should last out here for 10 to 20 years; it should serve 10 acres, and cost Re. 1 about to put up. The saving (if it is efficacious), on a 120 year rotation by the method giving the smallest figure, is Re. $\cdot094 \times 10 \times 10 =$ Rs. 9·4 for 10 acres for 10 years. On Nilambur figures, at 4½ per cent., the saving would be Re. $1\cdot53 \times 10 \times 10 =$ Rs. 153, or Rs. 15·3 per acre for 10 years, which is considerably more than the total nett surplus from most of the older Working Plans in this province.

A rough estimate of the cost for 10 years is given below :—

| | |
|---|---|
| 100,000 acres; 1 box for 10 acres = 10,000 boxes, @ Rs. 2 per box ... ... ... | 20,000 |
| Cost of investigating officer, and his travelling allowance, and his staff, Rs. 2,000 per month, = Rs. 24,000 a year for 10 years ... ... | 2,40,000 |
| Incidentals, Rs. 4,000 per annum ... ... | 40,000 |
| Total ... | 3,00,000 |

This expenditure of Rs. 3 lakhs in 10 years is estimated to save Rs. 15 lakhs worth of damage from defoliation alone if the experiments are successful. The annual increase in the area of plantations is excluded, as is the saving due to the destruction of other insects, while the experience and knowledge gained by the investigating officer in other matters should be a large item on the credit side.

J. M. D. MACKENZIE,
*Deputy Conservator of Forests.*

# PAPER-PULP SUPPLIES FROM INDIA.

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A lecture delivered at the Royal Society of Arts, London, on 3rd May 1921—Sir Robert W. Carlyle, K.C.S.I., C.I E., in the Chair.

1. It is a commonplace observation now that the question of the world's paper supply has arrived at an acute stage. We see it referred to in more or less lachrymose tones in almost every paper we take up. Our pockets test it daily in handing out twopences instead of pennies, the fivepenny five quire packet with twopence for twenty-five envelopes and the halfpenny newspaper have disappeared and we are studying economy in a direction we never thought of before. The days of prophecy are past and those of famine are actually here.

2. In 1913 the world's consumption of paper was estimated at ten million tons annually, increasing at the rate of 25 per cent. every ten years. It must be now nearly twelve millions or would be if the supplies were available. Of this about 80 per cent. is produced from wood—coniferous wood and preferably spruce. In 1913, although there had been a slow but gradual appreciation of values during the previous ten years, it was still possible to deliver chemically prepared pulp in this country at £9 to £10, and mechanically prepared, or ground wood-pulp, at £5-10-0 to £6 per dry ton, and newsprint paper could be produced for a penny per pound.

3. Now values are four to five times these figures. The causes stated in order of their importance from less to greater are these:—

(*a*) The slow but gradual rise of values in pulp and all that it depends upon dating from the period of lowest prices about fifteen years ago. During the war this

was, by reason of controls, restrictions and reduced consumption, more or less in suspense but has now fallen on the industry with five years' cumulative effect.

(*b*) The universal appreciation in value of timber for constructional purposes. The saw-mill is now a better market than the pulp factory.

(*c*) Effects of the war in permanently increased costs for labour, freights, fuel and machinery, and equipment.

(*d*) The total cessation for six years past of manufacturing expansion.

(*e*) The demand for wood has outrun the supply. The trees will not grow as fast as they are cut.

The last of these is the root cause of the trouble and is a constantly increasing menace. It does not necessarily imply that the world's stock of timber has been seriously depleted but it does mean that the forests most favourably situated for exploitation—the areas which produced the penny per pound newsprint—have been largely reduced in productiveness and in many instances destroyed for ever. Expansion in wood-pulp production must seek its supplies at greater distance and increased cost. Notwithstanding this the new values of pulp, making all allowances for temporary inflation, make such expansion abundantly justified. How much greater therefore is the justification for the introduction of a material which is one of nature's waste products, which reproduces itself naturally and rapidly, for which no saw-mill competes and which offers itself at nature's valuation, which is next door to nothing.

4. So we ask ourselves the question, what can India do to fill the gap which has been created? The answer is a great deal though not so much perhaps as I sometimes hear assumed. When the threatened shortage of paper supplies began to be agitated, some fifteen years ago, I remember an eminent scientist issuing what was intended to be a reassuring statement to the effect that "a paper famine was unthinkable because paper could be made from any vegetable substance and the world teemed with that."

The dictum was seized upon by the press and circulated round the world and no doubt brought comfort to many anxious consumers. But like many other assertions of many other eminent scientists, it was, considered as cold fact, perfectly true and at the same time, considered as a practical contribution to a difficult problem, perfectly misleading and fallacious. Paper *can* be made from any vegetable substance but money can't, and the paper-maker has a quite natural reluctance to make paper *unless he can transform it into bank notes. But* our eminent scientist's utterance gave rise to a whole crop of wild-cat proposals to make paper from everything, anything, and sometimes bordering on nothing. Nature, however, is not so fantastically generous as that. He whom she would favour must delve into her secrets slowly, deeply, carefully ; hoping all things, proving all things, until finally he can hold fast to that which is good. This has been in essence the principle upon which the investigations of the Indian Forest Research Institute, to which I am about to briefly allude, have been carried on. We have thought it more important in the early stages of our proceedings to save people's money than teach them how to make it, for nothing is more fatal to a promising industry than a disastrous failure at its start. At the same time, while paying considerable attention to the how-not-to-do-it programme and weeding out the duds we have met with encouraging success on the positive side. Our eminent scientist was an all-in, whole hog, hundred per cent. man. We have knocked ninety-five off that but remain quite pleased with the five which have survived. The truth is that out of the hundreds of thousands of species available, a large number have to be rejected because of the cost of isolating their cellulose, a further large number because the cellulose is no good when you have got it, not to mention others which grow in economically inaccessible situations or are too valuable for other purposes. The net result is that so far we have found only two small groups, both belonging to the Gramineæ, which are economically sound as *regards the quantity and quality of their cellulose* and the manufacturing conditions under which they can be exploited,

These are bamboos and a few Savannah grasses. But, though few in number, in the aggregate they mean something considerable. It is, I think, a modest estimate to say that from bamboo, taking only that which is available under *possible* manufacturing conditions, Burma, Bengal, and South-West India could produce ten million tons of pulp per annum, and Assam, from Savannah grasses, three million. India could therefore produce pulp for the whole world. Consider also the growth conditions under which this is obtainable. To grow a spruce or fir tree to pulp-wood size takes from 40 to 60 years, with the result that a factory which may at its start have its supplies at its back door finds these year by year receding into the distance with constantly increasing transport costs. Bamboos and grasses come to maturity as yearly or eighteen monthly growths and all you have to be careful of is not to reduce the reproductive vigour of the plant by too frequent cropping. With bamboo this may mean a three to five year rotation of cropping and with grasses two to three years. We must therefore have a sufficient area to exploit to allow of these rest periods but that only means that for a ten thousand ton pulp output per annum with average figures for yield and rotation, a 20,000 acre reserve will keep a factory going in perpetuance—a vastly different condition of affairs from those governing a wood-pulp installation which lives on its capital from the start or must adopt a reafforesting policy, which reacts badly upon costs.

5. Bamboo for paper-making is no new suggestion. In the seventies the late Thomas Routledge, well known as the successful pioneer of Esparto grass, experimented with it obtaining encouraging results as far as quality and suitability were concerned but failing on the economic side partly because of its resistance to bleaching, but chiefly because just at that moment wood-pulp came in with a rush and more than filled the demand. In 1905 Mr. Sindall, at the instance of the Government of India, carried out an extensive investigation in Burma, with results considerably more encouraging than those of Routledge, though still somewhat disappointing on the bleaching side, and, at that date, cheap wood-pulp still controlled the market. In 1909 the Government of

India, at the instance of Sir Joseph Miller and Sir Robert Carlyle who succeeded him as Member of Council for Revenue and Agriculture, deemed the time had arrived for a thorough enquiry into the whole subject and handed it over to the officers of the Forest Research Institute then under the presidency of Mr. L. Mercer, C.I.E., Mr. R. S. Pearson, C.I.E., conducting the forestry side of it. The chemical branch of it was begun at the Allahabad Exhibition of 1910, under the presidency of Sir John Hewett, then Lieutenant-Governor of the United Provinces, and the directorship of Mr. P. H. Clutterbuck, C.I.E., Conservator of Forests, and afterwards continued at the Forest Research *Institute*.

6. Hitherto the Institute's Laboratory work has been supplemented by tests at Papermills, by the courtesy of their owners, but Government has now ordered in Scotland a complete pulp and paper-making plant on a sufficient scale to permit of factory methods being used. This is to be erected at the Institute and will immensely reinforce its usefulness. I would like in passing to call attention to Government's policy in thus carrying out the enquiries initiated by Sir Joseph Miller, Sir Robert Carlyle and Sir John Hewett as an evidence of its keen interest in the industrial development of the country.

7. The chemical branch of the enquiry was begun under conditions considerably more favourable than those with which Routledge and Sindall had to work. The uncertainties on the forestry side had been largely cleared up by Mr. Pearson's work so there was no longer the risk of wasting time and effort on species and areas which he had shown to be of doubtful value. Considerable improvements had been arrived at in digestion methods and particularly in the recovery and re-use of soda from the waste liquors, largely reducing the cost of chemical treatment. In Routledge's time a recovery of 40 per cent. was regarded as good, now from 80 to 90 per cent. is not unusual. Most important of all, market values of wood-pulp were no longer on the down grade and the call for a new source of supply was becoming insistent. The problems to be faced were mainly those concerned with the cost of bleaching. It was evident that the dark brown colour of

the unbleached pulp hitherto produced was not its natural and unadulterated colour which, in carefully prepared samples, is a light grey faintly tinted with brown. The dark brown was a degradation result produced by the re-absorption by the *cellulose*—which, as evidenced by its use in blotting-paper, is one of the most absorbent substances known—of some of the complexes produced by the combination of soda with the *solubles in the raw material*. The first step in the enquiry therefore resolved itself into the isolation and separate examination of these. This resulted in the separation of the plant constituents into a series of groups based on their degrees of solubility. Each of these groups is a complex one exhibiting the group substance in several forms and types, all of which are of interest to the organic chemist and upon which much valuable work has been done by Cross and Bevan and others—in fact, it is upon the foundations laid by Cross and Bevan that our work has been built—but what interests the pulp manufacturer chiefly is the problem of *getting into solution* the non-cellulose constituents of his raw material.

8. Proceeding on these lines it was found possible to separate the plant constituents into four groups having marked and striking differences of solubility. In order of solubility beginning with the least resistant they are :—

*Group I.—Starch* and its secondary and transformation products—all soluble in boiling water.

*Group II.—Pectose*, soluble in one to two per cent. caustic soda solution at boiling temperature.

*Group III.—Lignin*, separated from cellulose by the chlorination method of Cross and Bevan.

*Group IV.—Cellulose*, the insoluble residue.

An average analysis of bamboo on these lines will give results in round figures as follows :—

| | | |
|---|---|---|
| Starch Group | ... 12 per cent. | There is also a trifling amount of wax and silica in the cuticle which goes into solution with the Pectose group. |
| Pectose ,, | ... 20 ,, ,, | |
| Lignin ,, | ... 15 ,, ,, | |
| Cellulose ,, | ... 53 ,, ,, | |
| | 100 ,, ,, | |

The characteristics of the three soluble groups in their behaviour with soda are as follows :—

*Starch* in its primary form gives a clear colourless solution but its quantity present in a total group content of 12 per cent. does not exceed a sixth. The other 10 per cent. of secondary starches form a dark brown nearly black solution of great pulp staining power. The *Pectoses* yield a dark brown staining solution which is gelatinous and therefore powerfully resistant to removal by washing prior to bleaching the pulp. The *Lignins* give a pale brown or amber coloured solution, clear, limpid and not gelatinous so that its faint stain is removable by washing. Now, since the raw material does not break down into pulp and *therefore into a condition permitting re-absorption*, until the lignin has been removed, the next step seemed clearly indicated, *viz.*, remove the substances which produce the objectionable stain on the pulp *before you attack the lignin*. It is fortunate that nature has made her arrangements to facilitate such a separation process. She gives us a beautifully graduated ascending scale of solubilities combined with a descending scale of staining effects. Had the opposite condition prevailed, had the most resistant, lignin, been also the worst staining factor we would have come up against a dead end.

9. Cellulose and lignin in combination form that old acquaintance of our schooldays, woody fibre, yet the analysis is very dissimilar from that of the substance we usually describe as wood which has a much larger proportion of lignin, the pectose group is replaced by a comparatively small content of resins and gums while the starch group is barely recognisable in a small percentage of mucilage. The large quantities of starch and pectose found in bamboo and in all Gramineæ are not in combination with the lignified fibre but represent stages of transformation in the plants laboratory of the primary food substance, starch, into the ultimate permanent products lignin and cellulose. In speaking of lignin as a group some qualification is necessary. It certainly exists in several types of varying resistance but not necessarily in the same plant. It is the substance which gives rigidity and

resistance to the cellulose against the opposing forces of wind, rain and decay and it does not appear likely that nature wastes effort in providing annual grasses with a protecting medium of the same resistance as that necessary for a tree which may live for centuries and this hypothesis is borne out by facts. Thus Esparto grass, which exists for a few months, has only about 6 per cent. of a lignin which is capable of reduction at temperatures below 130°C. and may even be dealt with by strong soda solutions and prolonged treatment at ordinary boiling temperature, whereas wood may contain as much as 40 per cent. of a lignin which is strongly resistant to great density of soda at temperatures as high as 170°C. Bamboo, whose life is not more than thirty years in the case of the longest lived species, is provided with a lignin intermediate to these in quality, capable of attack at 130°C. although not fully soluble under 150°C.; the difference between these figures being probably due to physical causes related to penetration of the reagent into a dense, compact and colloidally protected structure.

10. From these results we evolved the process which has been called Fractional Digestion to distinguish it from the earlier method of overhead digestion—'overhead' in the sense that all solubles are dealt with together by a treatment drastic enough to secure the resolution of their most resistant member and therefore unnecessarily severe for the less resistant groups, and which leaves the pulp steeped in a residual liquor containing all the objectionable staining matter referred to. Such a system has for long been recognised as scientifically unsound and we think we have proved it to be also economically unsound. It must necessarily be conducted with a large and wasteful excess of soda, first, because the lignin is not attacked until the digestion temperature has risen above 130°C. at which stage the starch and pectose groups have already been brought into solution and have neutralised a considerable amount of the soda. That which remains will not be of sufficient strength to deal effectively with the lignin unless the original liquor contained a large excess. In this connection it is well to bear in mind the effect which density has upon the

activity of soda solutions. You may have present the total quantity of soda necessary to effect your object, but if it is distributed throughout so large a volume of water that density is reduced below a certain well marked degree you will not get the result you wish. A notable example of this is provided in the mercerisation of cotton cloth. The minimum density we have found necessary to give rapid and effective resolution of the lignin of bamboo is that represented by a 4 per cent. solution of standard caustic soda and it must be of this density at the point at which the attack on lignin is commenced. Under the limitations of the overhead method it will not be of this density at that point unless it carried, at the beginning of digestion, a very large excess. Now since the theoretical quantity of soda required to neutralise the acid bodies, pectose and lignin, is only about 16 to 17 per cent. it is evident that the overhead method, with its consumption of 25 to 27 per cent., is compelled to employ, and to waste, a considerable excess. A second reason for the use of this excess is one also imposed by the defects of the method. It does to some extent check the pulp staining by holding more thoroughly in solution the gelatinous pectoses. It is a common observation among paper-makers that the more soda used the less is the consumption of bleach.

11. The best results hitherto obtained by the older method have been round about 26 per cent. of soda calculated on the raw material weight and 16 per cent. of standard English bleaching powder calculated on the unbleached pulp weight. These we have been able to reduce to 19 per cent. and 11 per cent. respectively so chemical cost is now considerably below the best wood-pulp practice. Both sets of figures, for soda and bleach and for both methods, are subject to variations up or down of 1 to 2 per cent. in accordance with the slightly varying analysis of species. There is also a gain of 2 per cent. in pulp yield in the fractional system owing to its less drastic conditions of both digestion and bleaching and a considerable saving in capital cost of the soda recovery plant. In the overhead system the wash liquors used in bleaching out the spent soda from the digested pulp are staining liquors and cannot be used again for digestion. They must go to the recovery

plant and as they are of low density they must be concentrated in an expensive multiple effect vacuum apparatus. As a result of the clean cut effected by the fractional method between the staining and the non-staining liquors the wash liquors can be used up in the chain of operations comprised in the regeneration of the recovered soda and the charging of the digesters. Only the digestion liquors need go to the recovery and these are of sufficient density to be dealt with by a comparatively inexpensive concentrating and calcining plant.

12. In factory practice it is not necessary to deal with the starch and pectose groups separately. They can be extracted together by a one to two per cent. soda solution—the water deals with the former and the soda with the latter—and the liquor used for such combined separation is preferably that previously used for a lignin digestion as long as it contains sufficient free soda to effect the purpose. In quantity this is equivalent, for bamboo, to from 6 to 7 per cent. on the raw material weight. The high temperature lignin resolution should therefore be conducted with about 7 per cent. more than is necessary for the lignin treatment thus giving it the advantage of high density already alluded to and securing that the residual liquor from the operation shall contain sufficient free soda to effect the pectose resolution in a subsequent charge of raw material. Both operations are therefore conducted with one volume of liquor with obvious advantage to the recovery process and there is also exhibited that curious property of some colloidal solutions that they are more effective solvents of another colloid than pure solutions. The pectose resolution may, with advantage in hastening the process, be conducted at temperatures higher than boiling as long as these do not approach the point at which lignin begins to be affected. As this is somewhere about 130° we can safely go up to 120°C.

13. The figures given above are those resulting from the use of a 'straight' soda liquor, that is one manufactured from carbonate of soda and of which the essential reagent is sodium hydroxide or caustic soda; but the modification known as the

sulphate system is equally applicable to Fractional treatment and with results corresponding comparatively for the two methods with those given above. With it the losses during the cycle of operations are replaced by crude sulphate of soda instead of carbonate and the resulting digesting liquor contains caustic soda and sulphide of soda in the proportions of about three to one. For the overhead method it does possess advantages such as would compel us to use it were we tied to that system. These are—

(*a*) the sulphide does more effectively deal with the gelatinous pectoses than caustic soda and so to some extent checks pulp staining ;

(*b*) the sulphide checks to some extent hydrolysis of fibre at high temperatures by the caustic soda and so results in a slightly higher pulp yield.

Its disadvantages are—

(*c*) sulphide has little effect upon lignin and to maintain the quantity of caustic soda necessary to deal with it the combined total of this and sulphide is 2 to 3 per cent. more than is required with 'straight' soda liquor ;

(*d*) crude sulphate of soda contains considerably less real alkali than the usual commercial form of carbonate which is practically a pure article, consequently a larger quantity of the former must be imported at a high freight cost ;

(*e*) the objectionable odour it evolves would rule it out in populous districts though this will probably not apply in the localities suitable for bamboo pulping. Since Fractional digestion effectively gets rid of pectoses before the real digestion, that of lignin begins advantage

(*a*) is cancelled out and advantage (*b*) considerably reduced in value by the lower temperature at which it is conducted, so the choice between the two is reduced to a question of the relative costs of the actual soda contents of sulphate versus carbonate of soda plus the 2 to 3 per cent alluded to in (*c*). Where freight cost is high the lower soda content of sulphate and the additional 2 to

3 per cent. referred to may quite possibly leave the advantage with carbonate notwithstanding the lower cost of the former at its point of origin.

14. It will be evident from the above that our efforts have chiefly been along the line of soda treatment. Considering that bamboo is a grass exhibiting all the characteristic chemical constituents of grasses in general, and specially in the large content of unbleachable starch and pectous matter. It seemed to us that success was more certain along the lines held to be essential with grasses already in use such as Esparto, and the other standard system of treatment extensively used for wood, known as the sulphite method, has never been seriously proposed for these. But this does not rule out entirely the application of the latter to bamboo and simultaneously with our efforts an investigation on such lines has been going forward in this country, the digesting liquor being a bi-sulphite of magnesia. It is uncertain if it will result in lower costs than soda treatment but it will probably succeed in producing a distinctive type of pulp which will be all to the good of bamboo as a whole and reinforce its claims as an alternative to wood-pulp. The latter is produced in about equal quantities by both methods and each is valued for its distinctive paper-making qualities.

15. The preparation of bamboo prior to digestion has given rise to some difference of opinion. It is somewhat noteworthy that such differences as exist relate entirely to the practical details of treatment. No differences exist as to the suitability of bamboo for manufacture of papers requiring high bleaching and printing qualities. As regards preparatory treatment two schools have arisen, the crushers and the chippers. Reduction to chips is the wood-pulp practice and its advocates appear to be in danger of a wood-pulp obsession which renders them somewhat blind to obvious differences between the two materials. They are undoubtedly entitled to make all the argument they can from the fact that crushing expands the volume of the material to nearly double and therefore apparently reduces the capacity and output of the digestion to half that obtainable with chipped material. I

say apparently for the actual result is not quite so bad as that. By reason of its less resistance to liquor penetration crushed material digests in three-fourths of the time required for chips, so if the output of a digester charged with chips is represented by 15, the output of one charged with crushed material is not 7½ but 10. Further, crushing does not create any additional recurring costs but merely a greater capital outlay for the additional digesters required. Still the objection is a valid one and entitled to full consideration but we think it is more than counterbalanced by what emerges from a critical study of the physical and constructional features of the two materials, thus—

(*a*) the fibre bundles of bamboos lie perfectly parallel to each other with no cross-graining and no interlacing, they split cleanly and crush perfectly without reducing to dust. Wood will not crush without a considerable loss through dust;

(*b*) bamboo is thickly studded with groups of sap-canals which run perfectly parallel throughout the whole length of the stem. In the dry material these are filled with air, which, being in a state of capillarity, is extremely difficult to dislodge, and, in the case of chips, offers a powerful resistance to the penetration of liquor besides adding to the buoyancy of the mass and tending to float a portion of it above the liquor. The splitting, which is the first effect of crushing, runs along these canals which are thus laid open to attack by liquor on their interior surfaces and the capillary air is got rid of. Wood presents no such feature;

(*c*) bamboo, throughout the entire length of stem, is of homogenous one-aged, one season growth. Wood, if say 60 years of age, has its heartwood 60 years old while its outer ring of growth is one year old. Therefore it must contain differences in density and quality and therefore there must be a proportion of undigested chips in wood-pulp digestion. There is no need for such a *must* in the case of bamboo;

(*d*) the nodes of bamboo, contrary to general belief, are not denser than the internodes. Their specific gravity is about 5 per cent. less. But they contain more pectose and lignin and their collodial resistance to liquor penetration is therefore greater. The antidote to this is opening up their tissues completely. By crushing this can be done so thoroughly that they can scarcely be distinguished in the general mass. As chips they must result in a considerable proportion of undigested specks and blemishes in the pulp.

The chipping school under the influence of their wood practice obsession are quite reconciled to the presence of this undigested matter in their pulp. They regard it as natural and expend their energies upon means of screening it out of the pulp after it is cooked. The crushers say it ought not to be there at all, that there need be no undigested chips in the pulp except occasional accidentals due to particles of raw material getting lodged over rivets or otherwise hung up in the upper part of the digester beyond the reach of liquor, and they think this is a result well worth attaining at the cost of somewhat larger digester plant, and they claim further that since crushed material will digest with less drastic conditions of time, temperature and soda the digestion cost is less and the pulp yield more.

16. In proceeding now to review the economic side of the matter let us disclaim at once any intention of basing estimates upon the present values of wood-pulp. These are about £45 per ton *c. i. f.* at British ports and undoubtedly represent considerable temporary inflation. Any attempt to arrive at what may be the normal price of wood-pulp in this country when inflation has been worked off can only be a more or less intelligent appreciation of events, but considering that costs of production for labour, fuel, chemicals, machinery, freights and wood are three to four times what they were in 1913 and that these advances are probably permanent with wood still tending to rise, we shall not perhaps be far wrong in putting it at £28 per ton. If this is considered too high the sequel will show that it is a figure permitting of

considerable variation downwards. On similar grounds we would put the future normal price of mechanical wood-pulp—which is not cellulose at all but only ground raw wood—at £16 per ton. Under the transport conditions I will describe later, bamboo can be delivered at manufacturing sites in Burma at a cost of 13*s.* 6*d.* to 15*s.* per dry ton, equivalent to from £1-11-3 to £1-17-6 per ton of unbleached pulp. Compare this with the like cost for wood-pulp which is from £10 to £12.

Manufacturing charges, inclusive of liberal allowances for depreciation of plant and contingencies, will be under £10 per ton of pulp so that the total cost on board steamer in Burma ports will probably not exceed £12 per ton—about the cost of raw material alone in the case of wood-pulp. In freights, of course, wood-pulp, being nearer, has the advantage though not proportionally to distance since port and terminal charges, no inconsiderable proportion of the whole, are the same for any distance. At present from Burma ports, they are about £6 but this is abnormal and I am advised on good authority that the eventual normal figure will not exceed £4.

17. The prospects therefore are that bamboo unbleached pulp can be delivered in this country at a *cost* not exceeding £16 to £18. Freights, again, are not entirely a matter of export to this country. There is a growing demand for India, China, Japan and Australia, and to these countries freights would be in favour of bamboo pulp and against wood-pulp. The economic position thus disclosed has an interesting relation to mechanical wood-pulp for which we have assumed a future normal value of £16 per ton. I do not think it has ever been seriously suggested before that a chemically prepared pulp could be brought within competition distance in cost with a mechanical one, but the figures given above do now suggest such a possibility and it is not wholly a question of price. Mechanical pulp will not produce a useful paper by itself and it adds nothing to the quality of a sheet. It is merely a convenient filler, make weight and reducer of cost, and must be held together by a considerable admixture of true cellulose. No paper-maker uses it because he

loves it but solely because he *must* to get his cost low enough and he will willingly substitute for it a true cellulose if it does not cost him very much more, especially since he is well aware that such a substitution enables him more effectively to use fillers which are cheaper even than mechanical pulp, such as that good old standby, China clay.

18. Few industries are more sensitive to transport conditions. Including the product, six tons has to be transported in and out of a factory for every ton of product where coal is available. If wood fuel is used the total will be $8\frac{1}{2}$ tons. It does not necessarily follow that each of the primary materials required—which are bamboo, fuel, limestone and imported soda—must be available under ideal transport conditions. It may be the case that some extraordinary advantage in one of them enables the manufacturer to raise his cost limit for another but it is evident that next to the raw material, transport is the ruling factor. Its importance may be illustrated by my own recent experience. During the past eight years I have been asked to revise some sixteen propositions for establishment of factories. Of these, only three failed on account of defects in the raw material supply, nine had to be rejected on transport conditions and only four satisfied all requirements. Judging from enquiries I receive this phase of question receives little attention and a sufficient supply of raw material appears to be popularly regarded as a satisfactory foundation for the industry.

19. In a previous paragraph I made a statement to the effect that India and Burma could produce ten million tons per annum under *possible* manufacturing conditions,—possible, that is, with a normal value of £28 per ton in England,—but the areas included in such a survey are naturally capable of being divided into best and second best and the best are probably not more than a fifth of the whole. They are to be found chiefly in the coastal belt of Burma and North-Eastern Bengal and Assam with a smaller area in South-West India. I have myself explored a considerable area of the coastal region of Burma where the transport conditions are nearly ideal. Numerous rivers, many of them tidal to 100 miles

from the sea and with good rafting water above that, intersected with creeks and connecting channels, and down which bamboo, felled upon their banks, can be floated to manufacturing sites on deep water or within easy reach of ports and anchorages by the aid of lighters. If wood fuel is not available—and if frequently is—coal from Calcutta or oil from Rangoon can be had and limestone, also by water, exists at several places on the mainland or islands close to the coast. The only foreign import required carrying a high freight cost is the small amount represented by 15 to 20% of the total soda consumption.

20. There is one peculiar feature of bamboo as to which a warning should be issued, *viz.*, the extraordinary phenomenon it exhibits of cyclical gregarious seeding and death. A few species do follow the usual rule of grasses in annual seeding and a few others seed sporadically but most of the important ones flower in cycle of long period and gregariously, and each species has its own length of cycle. It goes on reproducing itself by shoots thrown up from the root year after year for twenty, forty, or sixty years until, feeling old age approaching, it throws all its remaining energies into producing an enormous crop of seed and then lies. The new generation, although ultimately destined to produce culms which may be 120 feet in length and six inches diameter at the butt, throws up a first crop of diminutive stems perhaps eighteen inches high and less than a quarter inch thick. Next year brings a crop somewhat larger and so on increasing year by year in strict proportion to the growing power of the plant to produce starch and store it, in its roots until, after from four to ten years—the period varying with species, soil and climate—it is again throwing up its full sized culms. Note also, as a striking example of nature's silent dynamic, that these stems which, as I have said, may be 120 feet by 6 inches are produced of full height and diameter in four months. It is one of the few plants which you can literally see grow. Its branch and leaf system are developed in its second season and it is then fully matured.

21. It will be clear from this that a factory planted in a district without some enquiry having been made as to the seeding

cycle might find itself suddenly bereft of supplies for a prolonged period. There are two methods of insuring against this, first, the next seeding period may be known to be at such a date that supplies can be depended upon for a period long enough to secure an ample return on capital invested in the undertaking; and second, the presence in the area of an alternative species which, as is invariably the case, does not flower at the same period. It is satisfactory to be able to add that most of the important species have seeded within recent years or are now in process of doing so as if nature had anticipated the demands we are about to make.

22. The crisis now threatening the paper industry, and, it may be added, the large and increasing family of industries based on cellulose and of which artificial silk and celluloid are types, is not an unprecedented experience. It is historic and oft repeated. Beginning with the failure of rag to provide for a continually increasing demand the trade during the last hundred years has passed in succession through the phases represented by the utilisation of textile wastes, straw, esparto and wood, each in turn hailed as salvation and each in turn failing to cope with the requirements or finding a better market. It remains a fundamental axiom of the industry that it is a "picker up of unconsidered trifles." As the interests of other manufactures in a material increases so in proportion that of the paper-maker decreases. They can all pay more for it than he can. I have been trying for twenty-five years in various parts of the world to find a solution for this recurring trouble. As the final considered result of that experience I venture to express the belief that no permanent solution of it can be found except in the vast stores of annual—and I lay much stress on the annual—products of the forests and waste places of tropical and sub-tropical regions. Enormous in their volume, frequently co-existing with splendid transport and manufacturing facilities, continuous and rapid in their natural reproduction and easily converted by modern methods, they provide a field of enterprise of which we may well hesitate to prophesy the expansion and wholly fail to see the

end. And remembering recent experience when we found ourselves almost wholly dependent upon foreign supplies, may we be pardoned for uttering a little pæan of congratulation that such areas are within the Empire.

## THE DESTRUCTION OF THE FOREST.

"The field is wasted, the new wine is dried up, the oil languisheth............for the harvest of the field is perished, the vine is withered and the fig tree languisheth, the pomegranate tree, the palm tree also and the apple tree, even all the trees of the field are withered: for joy is withered away from the sons of men.

"How do the beasts groan! the herds of cattle are perplexed because they have no pasture; yea the flocks of sheep are made desolate. O Lord to thee do I cry: for the fire hath destroyed the pastures of the wilderness and the flame hath burned up all the trees of the field.

"Yea the beasts of the field pant unto thee for the water-brooks are dried up and the fire hath devoured the pastures of the wilderness."

No better description of the devastation of the forest fire could be written than the above words of the prophet Joel. He describes in forceful language not only the immediate penalty in the burning of the standing fodder and the destruction of the trees but with a knowledge of the forces of nature far in advance of some of our politicians at the present day he realises the ultimate penality to be paid in the drying up of the water-brooks and the dessication of the land. The fire described must have been one of unusual magnitude similar no doubt to those experienced this year, which have done incalculable damage to the pine forests of the hills. The origin of these fires was largely incendiarism for the purpose of damaging Government property and in many cases the regeneration produced by 20 years' work has been utterly destroyed. Can it be said that the authors of this wilful damage

have been of service to their country? Blinded by ignorance and prejudice, unmindful of the teachings of history or the lessons of the past, they set fire to the primeval forests which cradled their race and watch with glee the flames destroying the face of their own fair land.

"A fire devoureth before them and behind them a flame burneth: the land is as the garden of Eden before them and behind them a desolate wilderness: and yea none hath escaped them. Like the noise of chariots on the tops of the mountains do they leap, like the noise of a flame of fire that devoureth the stubble."

Palestine, a land flowing with milk and honey, has been turned into a barren wilderness by the devastation of the forest. The fair islands of Crete and Cyprus, celebrated for their wealth and beauty throughout the ancient world, are decayed away, for their forests are no more. Northern Africa, the granary of Rome, is largely a wilderness of sand; and the glory of Spain and Mexico has vanished along with their woods.

But why should we turn to foreign lands for our terrible examples of the foolishness of man when all around us in India the consequences of this destruction are manifest everywhere.

The forests where the Emperor Baber hunted the rhinoceros have disappeared and in their place are found a waterless tangle of ravines, a nightmare land, accursed of God and man. The beautiful country along the foot hills, a land of streams and corn-fields and pleasant mango groves is washed away or buried under sand and gravel like the ruined cities of Turkestan. The outer hills are hideous and naked, scored with ravines, intersected with cliffs, devoid of shade or perennial water; and all so that man may graze his abominable goats and destroy the forest at his own sweet will. The water-courses of Kumaun are dry and choked with débris, a pleasant country of well-wooded hills is turned into a sterile waste by a race sunk in the abysmal depths of ignorance. With fire and axe they devastate their own land worse than any foreign foe, what care they for to-morrow! "Sufficient unto the day is the evil thereof." Within the memory of man hills

once clothed with forest are now bare and desolate, perennial streams are dried up. Instead of a shady land abounding in springs of water; heat, dust and cholera pervade the land. In spite of the evidences of their own eyes, their self-styled leaders, voicing the parrot cry of the mob, protest against forest management and fire-protection, and give their support to those whose one object appears to be the destruction of their own land with the utmost possible speed, so that their children may have neither water to drink, nor wood to burn, nor fields to cultivate.

The voice of wisdom as the voice of one crying in the wilderness which no one heedeth: the clamour of fools fills the air: and day by day the country passes along the road leading to the abomination of desolation spoken of by Isaiah the prophet.

"Arbores magnae diu crescunt una hora extirpantur."

"TROWSCOED."

## HANDBOOK OF FOREST PRODUCTS OF BURMA.

By A. RODGER, O.B.E., F.L.S., I.F.S., Superintendent, Government Printing, Burma, Rangoon, pp. 128. Price Re. 1.

It is to be hoped that this volume is only the first of a series of similar works for the other provinces of India.

The development of trade in Major and Minor Forest Produce has reached a stage when more detailed information is required than can be got from the standard authorities such as Gamble and Watt, whose works, though indispensable, are too condensed for present day needs and require to be supplemented, just as the general floras are now being followed by local lists and pocket floras.

The information on timbers is clear and usefully compressed but occasionally one notices that statements have been taken from the standard references without comparison with the results of recent enquiries. In a work of this description the object is

primarily to provide information to the outside trader and the description of the utility of the timber for his purposes is more important than descriptions of local uses which may have arisen from lack of supply of timbers more closely meeting local requirements.

There is a familiar ring about spear handles, cart axles and so forth, but does an export trader really want to know this? Is he not likely to be more interested in a timber's use as a substitute for some known constructional or joinery wood?

The arrangement under the Burmese names is good but the adherence to the grouping by natural orders seems unnecessary if the unbotanical reader is the one to be attracted. Owing to the paucity of English trade names an alphabetical order such as adopted by Boulger would not work but an alphabetical order of Burmese names with English names inserted and cross-referenced would have made the book simpler to use. As an example Aukchins a timber requires two separate references, similarly Budalet and others.

In view of the success of the Empire Timber Exhibition it is almost a pity that the publication was not delayed sufficiently long to allow of the trade names adopted at the exhibition being inserted.

In the actual printing of the names there seems a lack of uniformity. In some cases the English name appears in the leading type ordinarily kept for Burmese, in others the scientific name, while the Burmese is then given in the italics used elsewhere for the botanical authority. In one case *Murraya exotica*, the Burmese name is left out altogether and the trade name, "Tavoy satinwood," selected in place of the better known "Chinese Box." On page 42 we notice a mistake. The Andamans Black Chuglam is referred to *Myristica Irya* whereas it has been recently referred to *Terminalia Manii.*

Regarding the weights given for the timbers it would be well had some mention been made of the standard adopted, whether well air dried or simply the average of the weights given

by the text-books. In future no doubt a standard moisture percentage will be adopted. This is important since the value of P varies with the moisture content of the timber.

The sections dealing with minor produce are bound to be disappointing. The subject is so large and bound up with so many trades of which a forest officer probably barely even knows the names, that little more than what is given in the handbook can be expected until the investigation of these products is taken up systematically.

Under medicinal plants it is interesting to note that the author records the use of the leaves of *Vitex peduncularis* for fever, in view of the investigations recently referred to in these pages.

It may be thought that the above criticisms are unduly disparaging to what is undoubtedly a brave effort to disseminate a knowledge of our forest products. Such is not the intention of this review. Its aim is to point out possible improvements for subsequent editions or for similar productions from other provinces. Even if the author had nothing else to show for his time as forest research officer he need not fear the accusation of having wasted his time.

The printing and general get up of the volume are in keeping with what we have learned to expect from the Government Press, Rangoon. *Printers' ink* must be cheap there judging from the amount which comes off on the reader's fingers. In other parts of the world a book marker is more usually thrown in as a gift to the public.

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# INDIAN FORESTER

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## THE PHYSIOLOGICAL ANATOMY OF THE SPIKED LEAF IN SANDAL (*SANTALUM ALBUM*, L.).*

BY P. S. JIVANNA RAO, M.A., AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE, COIMBATORE.

In an article entitled "The Cause of Spike in Sandal," published in a recent issue of the *Indian Forester*,† the writer presented arguments in support of the view that the Spike in Sandal is caused by an insufficient supply of water to the plant owing to relations with unfavourable hosts. A study of the leaf with reference to the presence and distribution of starch in so far as this could be connected with the water-content of the leaf was also proposed.

### INTRODUCTION.

The anatomy of *Santalum album* was described by Chatin (7) in his *Anatomie Comparée des Vegetaux*. Behm (3) later gave a detailed account of the anatomical characteristics of the several

*Paper read at the Indian Science Congress, Calcutta, February 1921.

†Vol. XLVI, 1920—No. 9, pp. 469—487.

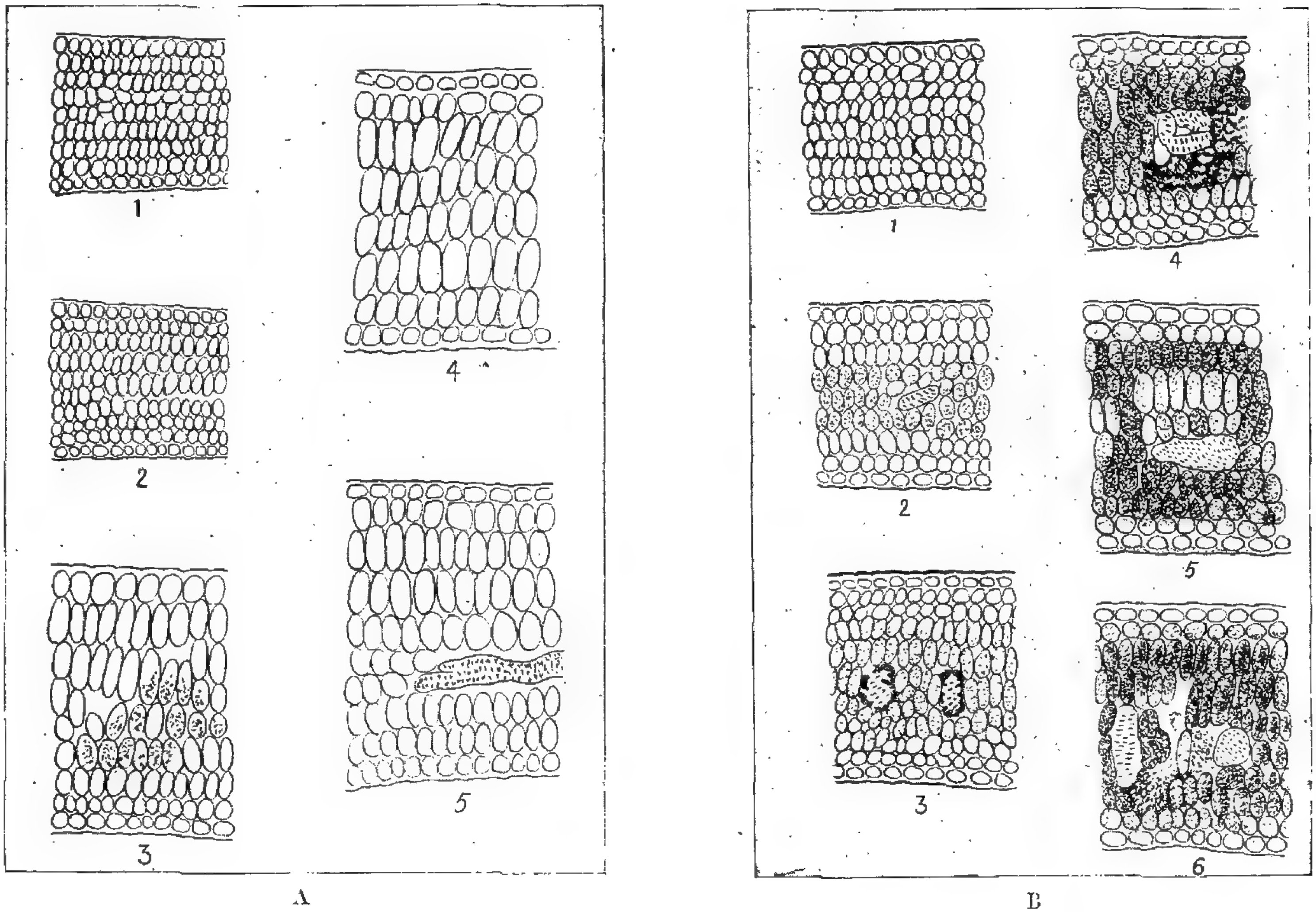
genera belonging to the *Santalaceæ*. Solereder (18) has given a general review of the anatomy of the whole family. While these works relate to the aerial organs of the plant the underground parts and especially the haustoria have formed the subject of special investigation by Barber (1) in his well-known memoirs.

The present investigation is confined to the starch content of the leaf of Sandal as it was thought that it constitutes the most essential feature of the Spike and the adherents of different theories regarding the cause of the phenomenon must certainly explain it in the light of their respective views.

The accumulation of starch was first noticed by Barber (2) and Butler (6). Coleman (8) who has described the anatomy of normal and spiked leaves at some length has also dwelt on the copious amount of starch present in the spiked leaves. It appears to have been assumed by these investigators that spiked leaves always contain starch or that normal leaves are always free from it though a statement of analyses of healthy and spiked leaves given by Coleman (8, p. 17) shows the accumulation in the healthy leaves. From an examination of a number of leaves in different stages it was found that starch is present in varying quantities in several leaves whether actually spiked or not and a study of the spike with regard to this point has, it is believed, thrown considerable light on the vexed question regarding the origin of the "disease."

## INVESTIGATION.

(1) *Method.*—Specimens of spikes were collected at Hassanur in Coimbatore District, at different hours during the day (25-9-1920) from a single plant which was completely spiked. These were at once preserved in dilute formalin and sections of all the leaves on the spikes from the youngest to the oldest still remaining on the twig were taken and mounted directly in solution of Chloralhydrate-iodine. Differences in the total quantity of starch were not made out as hand sections could not possibly be of uniform thickness. Instead, the distribution of starch in the mesophyll was carefully studied by means of camera lucida




Transverse sections of the successive leaves in (A) a normal twig, and (B) a spiked twig.

drawings and attention was also paid to the enlargement of cells and their number in a definite area.

Sections were taken in the same manner from (1) the leaves of a normal plant (2) leaves in an advanced stage of spike when the plant was in a dying condition and (3) leaves of a plant which was apparently normal but appeared to suffer from drought owing to removal or absence of hosts and on this account arrested attention.

(2) *Results.*—The internal structure of the spiked leaf reveals an interesting state of affairs. The six to seven lines of mesophyll are packed so closely as to leave no air cavities towards the lower surface. In the young leaves the cells forming the sheath round the vascular bundles or their ultimate tracheidal ramifications are the first to be filled with starch. In the next older leaves this precipitation of starch is noticeable in the central cells throughout the cross-section of the leaf and after extending to the lower mesophyll cells it is finally seen in the layer of cells beneath the upper epidermis. The cells of the lower epidermis also become filled with starch in the later stages.

The figures given below bring out clearly this gradually increasing deposition of starch from the younger to the oldest leaves in a single spike. The sections are drawings made with the help of camera lucida and each represents a portion confined to the hundred divisions (155 microns) of an ocular micrometer. The increase in the expansion of cells may be contrasted with that seen in the leaves from a normal tree plucked at the same hour and place as the spiked one. While the above represents a type of spike having both young and old leaves on it, other conditions also arise where all the leaves may be in the younger stages or on the other hand all of them may be in the older stages with cells fully expanded and containing abundance of starch. A large number of spiked leaves were thus tested before the following conclusions were drawn, *viz*:—

(A) In the earlier stages of the spike little or no starch is present in the younger leaves.

(B) Starch is present in all the leaves of the spike in the older stages.

(C) Starch disappears in the advanced stage of the spike when the plant is in a dying state.

(D) Leaves from an absolutely unspiked plant sometimes contain abundance of starch.

(E) In all cases there is a progressive increase in the quantity of starch from the youngest to the oldest leaves still remaining on the twig.

A rough calculation was made of the approximate number of cells in the layer just beneath the upper epidermis both in spiked and normal leaves by noting the number included between the ends of the micrometer and the details regarding the maximum breadth of the leaves and the number of cells in the hypodermal layer are shown in the following statement :—

| | Spiked Twig. | | Normal Twig. | |
|---|---|---|---|---|
| | Breadth of Leaf. | Number of cells. | Breadth of Leaf. | Number of cells. |
| 1st leaf ... | 4 mm. | 309 | 4 mm. | 413 |
| 2nd ,, ... | 9 mm. | 522 | 9 mm. | 813 |
| 3rd ,, ... | 4½ mm. | 290 | 18 mm. | 929 |
| 4th ,, ... | 8 mm. | 413 | 25 mm. | 1,290 |
| 5th ,, ... | 9 mm. | 522 | 28 mm. | 1,084 |

## The Cause of Spike.

### 1. *Lines of Attack.*

Final solution of this problem must take into account evidence of a threefold character :—

(*i*) Experimental proof.

(*ii*) Chemical evidence.

(*iii*) The physiological anatomy of the spiked leaf as compared with that of the normal one.

(*i*) It has not been possible for the writer to adduce direct experimental evidence in support of his opinion as this is a full-time work demanding longer and continuous stay in spiked areas. He, however, thinks that not only may normal plants

(1). Normal twig.

(2). Spiked twig.

(3). Intermediate stage.

(4). Intermediate stage.

Stages in the formation of spike.

be induced to form spikes but that spiked twigs, in the earlier stages at least, may be forced to resume normal growth. The former has been accomplished by Coleman (8) and lends support to the virus theory. The latter is necessary in order to safeguard the future of the plant.

(*ii*) Sprecher (19) has ascertained the osmotic pressures of the cell-saps of the healthy and mosaic plants of Tobacco and came to the conclusion that though the pressures were identical the molecular weight was not the same in both. The table of analysis shows a lower average for organic substances in the diseased than in the healthy plants and if, as Pfeffer (16) and Livingston (13) suppose the turgor pressure in the growing parts of plants is maintained by organic rather than inorganic substances, it is at least doubtful if a disturbance in the osmotic equilibrium in leaves is not indicated by the results of the analysis. Macdougal and Cannon (14) are of opinion that "the ash content of the cell-sap is ***not invariably*** to be taken as an index of its osmotic activity." The low percentage of ash in the spiked leaves of sandal against what is seen in normal leaves adds support to the writer's views.

## 2. *Discussion on the Physiological Anatomy.*

(*iii*) The changes noticed in the spike are such as would be brought about by a diminished supply of water. The presence of starch is by no means confined to twigs that are actually spiked but is a peculiarity which is sometimes noticed in leaves which to all outward appearances are normal. Such leaves are as a rule marked by a definite concavity which as Bergen (4) has shown is a feature characteristic of many plants and is most probably a response to intense illumination coupled with excessive loss of water by transpiration and low water-content. The maximum deposit of starch in such cases is round the vascular bundles of the leaf but this substance as described above gradually extends from the bundle sheath to the periphery until the whole of the leaf becomes crammed with it. This increase of starch in a centrifugal direction accords well with the view that the sugar concentration

in leaves is generally highest in the palisade layer producing the maximum osmotic pressure at this point and there is a downward gradient of this substance from the epidermis to the vascular bundles. Rywosch (17) arrived at this conclusion after certain investigations made by him concerning the translocation of substances by diffusion in plant organs.

The differences in osmotic pressure inferred from the unequal distribution of starch in leaf cells is also clear from what Ursprung and Blum (21) have recently shown to be the case for *Hedera*. These authors have given values in atmospheres for the different parts of the leaf in *Hedera* and came to the conclusion that the pressure inside the leaf increases from the vascular tissue towards the epidermis, the highest pressure being in the upper palisade layer. The ray cells in their investigation showed pressure from 2·1 to 2·6 against bundle sheath 7·3 to 9·3 and palisade parenchyma 8·7 to 16·4 and strangely enough in the spiked twigs of Sandal the medullary cells are among the earliest to form starch, the vascular sheaths next and the palisade cells last.

Measurements of the leaf cells from cross-sections of normal and spiked leaves in the later stages do not reveal any appreciable difference in size. The constancy of cell shape in organs of a homologous nature has been drawn attention to by Haberlandt (10) among others who says, "the cells composing a small organ are fewer in number than those which make up a larger organ of the same kind, not smaller in size." Ewart (9) determined this in the case of *Tilia europæa* and results to the same effect are available from the work of a more recent author (Tenopyr 20).

Three phases are recognised in the growth of an organ, *viz.*, the formative or embryonic phase, the phase of enlargement and the maturation phase. These are very intimately connected and as regards the first two phases the one essential condition is turgidity. The size of cells in both normal and spiked leaves being approximately constant, it comes about that in the formative stage, the division of cells is checked owing to lack of full turgidity but their enlargement is effected in due course by an increase in osmotic pressure due to accumulation of photosynthetic products and

diminishing water-content. That osmotic pressure is thus capable of providing the requisite energy for growth may be accepted as certain. Pfeffer (16) for instance states that "during plastic growth the stretching of the cell-wall is due to the osmotic pressure in the cell."

The actual method of growth in Sandal (as indeed in all plants) may be represented by means of an algebraic formula as follows :—

Assuming $x$ to be the number of cells with which the leaf starts the division of cells is according to the series :—

$$x,\ 2x,\ 3x,\ \ldots\ldots\ldots\ldots\ nx$$

but that the number of cells is not proportional to the increase in the size of the leaf (*vide* statement above) is due to the fact that not all the cells divide and that the second phase of growth, *viz.*, the enlargement of cells, closely accompanies the first phase. In the spiked plant on the other hand the division of cells is retarded and as the "disease" "runs its course" for a long period—three to four years according to McCarthy (15)—the series gradually gets less from $nx$ to $(n-1)x$, $(n-2)x$, $(n-3)x$, and so on until the $(n-n)x$ stage is reached.

The root cause of the spike must therefore be traced to those factors which limit the turgidity of the cells and thereby check their powers of growth.

### 3. *Rapidity of Growth in Spiked Twigs.*

One of the striking peculiarities of spiked twigs so often noticed is their continuous and rapid growth. After what has been explained above it must be clear that whether "growth regulates turgor" or "turgor growth" the two are most intimately connected, and as the older leaves soon lose their maximum osmotic pressure owing to the condensation of starch in them the scene of greatest turgidity is rapidly shifted to the topmost point of the shoot and the scanty supply of water that is available is perforce directed to the younger leaves till these repeat the process. It is interesting to see that with such a precarious supply of water the plant is still tenacious of life for even though

the trunk and branches are completely dry and desiccated the twigs still continue to bear tufts of smallest pigmented leaves which, however, are at a death point and fall off early. An examination of these leaves showed the leaf cells in a plasmolysed condition and a few starch grains confined only to the bundle sheaths. These minute leaves evidently receive an extremely low amount of moisture from the soil through the trunk and desiccated branches as Briggs and Shants (5) have shown this to be generally the case for all plants.

## CONCLUSIONS.

Barber (2) rightly attributed the "disease" to "root trouble" but unfortunately he was unable to connect the death of the root-ends and the haustoria with the death of hosts and the idea of disease led him to invoke the aid of the Cryptogamic Botanist. Coleman (8) after extensive investigations propounded the "virus theory" which has gained many supporters. The "unbalanced circulation of sap" theory advanced by Hole (11) has lately been supported by Howard and Howard (12) after a study of a similar phenomenon in the Peach.

The present writer agreeing in the main with the views of the Howards, Hole and others has elsewhere given reasons for ascribing the spike to the difficulties in getting an adequate supply of water owing to relations with unfavourable hosts. He believes that the evidence outlined in this paper concerning the physiological anatomy of the spiked leaf adds strength to this view and it is his intention to pursue the experimental aspect of the subject when opportunity next occurs.

My grateful thanks are due to Rai Bahadur K. Rangachariar Avl., for special facilities and encouragement given during the progress of this work.

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## PAPER-PULP SUPPLIES FROM INDIA.

*Mr. Raitt's paper on the above as read before the Royal Society of Arts, Indian Section, on 3rd May 1921 was published in our issue for August. This month we give the discussion which followed the reading of the paper.*

Mr. Sindall contributed the following observations :—

Mr. Raitt, in his address, shows that with regard to the preparatory treatment of bamboo for ultimate conversion into

paper two rival schools are in existence which he describes as the "crushers" and the "chippers." The argument on behalf of the crushing school has been exhaustively presented and it would, therefore, be interesting to know the line of argument adopted by the "chippers," so-called.

In this case the stems of bamboo are passed through a special slab-wood chipping machine, which cuts the bamboo into small chips similar to those obtained by the treatment of slab-wood. It is stated that such a process gives a much greater capacity in the digester, with a closer and better packing of the material. The digester is more easily and quickly filled and owing to the closer packing of the material less liquor is required. This in its turn means the use of a stronger liquor and ultimately a much smaller quantity would need to be evaporated for the recovery of the soda. Messrs. Boving and Co., who have developed this system, state that they are able to fill a digester of a capacity of six tons by blowing in the chips in about half-an-hour. Experiments were made by them in Sweden on a large scale, some twenty tons of bamboo having been utilised for the purpose, and it has been proved that the product obtained is perfectly satisfactory.

This firm have given considerable attention to the question of economy in the production of esparto and bamboo-pulp and are at the present moment engaged in the erection of a large esparto plant in Scotland based on the most modern practice of pulp treatment and the methods being introduced are certainly worthy of close attention on the part of paper-makers. The system as devised introduces many ingenious methods for economy in fuel and labour. The material is cut into small pieces, cleaned and dusted and then blown into the digesters. The requisite amount of caustic soda is run into the digester and the cooking proceeds by a new system of circulation. In present practice the material is cooked by blowing live steam into the mixture, with the result that the consequent condensation of the steam increases the volume of the liquor to be evaporated for the recovery of soda. In the new system the liquor is passed through the grass in the digester through an outside circulating system heated by high pressure steam

in such a manner that the steam condensed is drawn off separately and utilised for heating washing water or cooking liquor. The volume of liquor in the digester in this case is not increased and a definite saving is thus effected.

It is proposed to utilise this condensed steam for heating up the cooking liquor so that the pulp is at once supplied with hot liquor and this again means economy in steam.

When the pulp is sufficiently cooked the pressure in the boilers is utilised to discharge or blow out the boiled grass direct to the washing tanks or diffusers. This method is substituted for the present system of allowing the steam to blow out into the air or into water. The practical result is that the black liquor containing all the non-fibrous organic compound present in the original esparto has a density of something approximating 14° to 16° Twaddle as opposed to 6° or 8° Twaddle.

The clean pulp is flushed out of the diffusers by water, and passed over screens and sand traps similar to those employed for the production of wood-pulp.

The whole process is continuous, requiring very little attention and appears to be a great advance on the present system.

The same plant can be used and has been carefully designed for the treatment of bamboo. It appears that the knots in bamboo offer no difficulty and certainly results obtained on such a large scale as that involved in the treatment of 20 tons should afford sufficient evidence as to the value of the method designed by them.

The most important development, however, in connection with esparto, bamboo and similar materials such as Indian grasses, is the treatment of the black liquor obtained during the process of digestion. When these materials are treated with caustic soda some 45 per cent. to 50 per cent. of the original matter is dissolved and the liquor is then highly loaded with organic matter.

In the earlier days of paper-making this liquor was discharged into the open streams and rivers of the neighbourhood, but owing to the action taken by local authorities it became necessary to devise some method of dealing with this black liquor, the discharge into streams and rivers being forbidden. A method was

found in a process by means of which the liquor was evaporated to a thick consistency, in which condition the mass would catch fire and could be burnt, the organic matter in solution acting as fuel for a more or less complete incineration. The organic soda compounds were thus converted into crude carbonate of soda, in which form, after boiling with a definite proportion of lime, it was re-converted into caustic soda. The methods of evaporation, economy of washing water and scientific control of the several stages of treatment were gradually improved, and the recovery process, at first regarded as the outcome of a mere whim on the part of obnoxious local authorities, soon revealed itself as an *important factor in reducing costs of production.*

Of recent years, considerable attention has been given to a more scientific method of recovery in the hopes of obtaining more valuable bye-products than combustible matter. Rinman's process for the conversion of the soluble organic constituents into definite bye-products of *commercial utility, already well established for* wood-pulps in Sweden, has now been applied in these recent experiments with bamboo, and an estimate of bye-products available from a standard bamboo-pulp mill having a capacity of 10,000 tons air-dry pulp per year (using 22,000 raw material) is as follows :—

| Bye-products. | Estimated Kilos. | Price per Kilo. | Total Price. |
|---|---|---|---|
| 1. Methyl Alcohol .. ... ... | 388,000 | 3*s.* | 46,200 |
| 2. Acetone used as petrol, etc. ... ... | 330,000 | | |
| 3. Ethyl-methylketone (petrol) ... ... | 22,000 | 1s. | 38,500 |
| 4. Light Oils (petrol) ... ... | 220,000 | | |
| 5. Heavy Oils (Diesel oil) ... ... | 572,000 | 5*d.* | 11,917 |
| | 1,650,000 | ... | £96,617 |

or 1,625 tons.

Rinman's process is carried out on the following lines. The black liquor already suitably concentrated to the required density is mixed with a small proportion of caustic soda liquor and a carefully calculated quantity of quicklime. This mixture when showing a density of about 40° Beaume is kept at a high temperature in proper store tanks. The mixture is fed as required into a number of iron trays to the depth of about 2 centimetres. These trays fit into square shaped wagons, four of which are at one time pushed into distillation furnace, which is perfectly airtight when closed up ready for the operation of distilling. The temperature of the oven is gradually increased to 200° C., the heat for this process being obtained by burning gases which are given off during the distillation process, any extra heat being obtained from a gas generator using coke. At 200° C. the excess moisture is driven off.

The temperature is raised to 300° C., and at this stage the bye-products given off are mainly crude methyl alcohol and hydrogen gas. These products are drawn off in a suitable manner.

At an increased temperature of 400° C. the bye-products obtained are acetone and light oils.

The whole operation of distilling occupies about 18 hours. The furnace is then cooled and the wagons drawn out of the apparatus, the contents of each truck being tipped into water and causticised with lime. The lime mud, which is necessarily contaminated with the carbon left from the distillation process, is dried in a rotary furnace and ultimately burnt at high temperature in another rotary furnace heated from the gas generator already described. By this means the lime mud is reconverted into quicklime which can be utilised over again in the process of causticising the crude carbonate of soda obtained from the distillation furnace.

If the Rinman process proves commercially practicable on a large scale as applied to esparto and bamboo then the prospects for cheap bamboo-pulp seem bright. The quantity of bye-products obtained as shown in the above table amount to nearly

10 per cent. calculated on the original raw bamboo. At present the story reads like a fairy tale but the fact remains that mills are being erected in Great Britain, having all these new applications in view for the treatment of esparto and grasses and its application to bamboo is stated to be merely a matter of adaptation.

Mr. E. F. Heyerdahl, of Christiania, said that last year he investigated the sulphate process and made trials with different materials. He had had a long experience in the treatment of coniferous woods, and he had also been to South Africa, where a Norwegian Company had a concession for the utilisation of papyrus. He carried out experiments with that papyrus, treating it by the sulphate process: and then made experiments with wattle wood and crushed wattle bark by the sulphate process. Recently he had made experiments with bamboo. The author proposed to carry out his digesting process in steps, first taking away the starchy matter and pectoses by boiling water and very diluted caustic soda. The author claimed that the action of the sodium hydroxide on the lignins did not take place before 130 deg. C. That was right, and then most of the sodium hydroxide was already used up in dissolving the starch and the pectoses, but by the sulphate process there were two actual solvents on the lignine compounds, *i.e.*, sodium hydroxide and sodium sulphide. Sodium sulphide was a very strong resolvent for lignin, especially at high temperature, and he believed that sulphide acted more strongly on lignin than sodium hydroxide, over 130 and 140 deg. C. In treating bamboo, the sodium hydroxide would first dissolve the starch and the pectoses. That process would be completed at about 130 deg. C. and then the sulphide would begin to act and would completely dissolve all the lignins in the bamboo. Another point about the sulphide was that it did not act upon the cellulose fibres, and, therefore, higher yields were always obtained when the sulphate process was used, about 5 per cent. more yield on the material being obtained by using the sulphate process than by using the other process. When treating coniferous woods with sodium hydroxide, a brownish coloured pulp was always obtained, owing to the fact that during the boiling the iron in the wood and

the iron in the apparatus were dissolved by the sodium hydroxide and precipitated into the fibres. When the sulphate process was used, sodium sulphide dissolved all those iron precipitates and a light greyish pulp was obtained instead of the brown pulp. In all his experiments he had only used bamboo chips, as he considered the crushing of the complete culms was not economical from a practical point of view ; it required more power and he believed it was not good for the fibre. With regard to the yields, with the soda process, by a proportion of 19 to 20 per cent., he had obtained 42 per cent. of unbleached pulp, requiring from 16 to 18 per cent. of bleaching powder on the pulp, and an average bleached yield of 37 to 39. With the sulphate process he obtained yields of from 43 to 45 per cent., with a consumption of bleaching powder of 12 to 14 per cent., the proportion of actual alkali (NaOH $Na_2S$) being 18 to 20 per cent. When bamboo was cooked and made into a well boiled pulp it was very easy to treat. The washing process was very easily carried out, as the water penetrated through the pulp very readily, and the washing time was reduced to about one-quarter of the time required on coniferous woods. Chipping the bamboo without considering the nodes was not good ; there were too many nodes in the material and there would be a loss during boiling of about 5 to 6 per cent. The culms could be pressed in pressing rollers and then the pressed culms allowed to pass crushing rollers, which opened up the nodes and did not crush the internodes. The flat pressed culms with the crushed nodes could be chipped into chips of ¾in. to ⅞in. in length. By that process a loss of only about ½ to 1 per cent. of the material would be obtained, and at the same time the actual capacity of the digester could be utilised to deal with about double the amount of material that could be treated if crushed bamboo were employed.

Mr. Heyerdahl exhibited to the meeting some samples of bamboo-pulps.

Mr. Hamel Smith remarked that having always been very keen on the utilisation of bamboo for paper-making, he would like the author to say what sort of gospel it would be safe to preach to the tropics in the time to come. It was very easy to be too

sanguine on such points as had been outlined that afternoon, but after hearing a paper such as that which has been read, one realised the many technical difficulties which arose. Any one who had been used to sugar plantations could not help feeling that bamboos should be able to be cultivated on the same lines. One grew the cane within a certain area of the factory, taking good care to have the factory rather low down, if possible, because then the loads could be run downhill and the empty trucks uphill with greater facility. Also in regard to the question of transport, one should centralise the roadways or waterways so as to remove the finished product with greater facility. The experience on one estate, it seemed to him, might help on the other. Whether the production of paper from bamboo would ever become a private enterprise seemed a little doubtful. It was one of the queries he had often been asked, and he had never been able to give any satisfactory reply. Probably those who had been in the tropics would know that bamboo had been rather in bad odour on account of mosquitoes. The last estate he was on used to have most beautiful bamboos surrounding it. but he believed that the medical authorities ordered them to be destroyed as they collected water after the rains thus making a breeding place for mosquitoes. Would that sort of trouble rise in connection with large areas of cultivated bamboo for a factory? The sanitary authorities might raise the difficulty that the bamboos were inclined to encourage the presence of mosquitoes to a dangerous degree, and thus lessen the chances of final success.

Mr. Arthur Baker (Chairman of the Technical Section of the Paper-Makers' Association), said, the paper was the outcome of long and painstaking research in bamboo by Mr. Raitt, and showed what a great industry the paper trade was. In Canada and the United States the consumption of paper for newspapers alone was two million tons a year. Taking the question of bamboo and grasses, and considering it from the point of view of an industry which might be started in India, one had to look at the position of that country as a market. India was not a very big market for paper. He supposed that in pre-war days it used

probably about 80,000 tons of paper a year, of which the Indian paper mills, some nine in number, produced about 32,000 tons. India had imported about 10,000 or 12,000 tons of pulp, more than one-quarter of which had come from Germany and Austria. So that industry could not be started on any considerable scale. He agreed with the author as to treatment; he thought the sulphate process was undoubtedly the best, and that crushing was the correct method of dealing with the raw material. If bamboo was to be a raw material for the paper-maker, it would require to be made on the spot, as the sulphate process created rather objectionable odours which would not be tolerated in all communities. He thought bamboo would obtain a foothold in India for printings, and it might be exported to Australia, China and even South Africa. The question of the use of all new fibre materials resolved itself into an £ s. d. proposition. Unless bamboo could compete strictly with other raw materials, on an £ s. d. basis, it would never become an industry either in India or anywhere else.

Mr. Roland Green said that during the war they had used bamboo by crushing under a power hammer and boiling it in esparto boilers, where they had not more than 50 pounds pressure. The conditions were not at all good ; it wanted higher pressure and longer boiling. But they had found it quite satisfactory, and had had no trouble at all after the crushing had been arranged.

Mr. L. P. Andrews said, it seemed to him that bamboo was a most extraordinarily easy material to handle, and he could not help thinking that it was going to be a great factor in the future.

Sir John G. Cumming, K.C.I.E., C.S.I., in proposing a vote of thanks to Mr. Raitt for his paper and to Mr. Sindall for his kindness in reading it, said it had been known to him for many years that Mr. Raitt had been making researches in India regarding the possibilities of paper-making. Mr. Raitt, the Forest Research Institute, and the Department of the Government of India which controlled that Institute (of which the Chairman that afternoon had been one of the most distinguished members), deserved great credit for what had been done in that direction. His own interest in the matter was twofold. He had been over a great part of the area,

both in Bengal and Burma, to which allusion had been made, wherein bamboo forests of the nature required were to be found. Secondly, he was intensely interested in any form which industrial expansion in India might take.

Mr. G. M. Ryan, F.L.S., late Indian Forest Service, in seconding the motion, enquired whether other plants and grasses had been examined for the purpose of finding out whether they were suitable for paper-making? For instance, there was one plant, a common weed really, which he thought might be utilised for pulp and which could be obtained in very large quantities in India, namely, *Calotropis.* The fibre was already of use, but with the bark combined he thought it might be made applicable for paper. He, therefore, would like to ask Mr. Sindall whether it would not be possible to use it for the purpose of paper, as it contained a large amount of cellulose? With regard to bamboo, unfortunately nearly all the areas where bamboos grew were really on poor soil and unfit for agriculture, so that he did not think private enterprise could develop the industry. Government would have to organise the areas referred to especially for paper. There was a very large demand in India for bamboo for huts, etc. Therefore, in considering the amount of bamboo which would be available for paper, a large quantity would have to be deducted for local needs. It would not do to infringe on the existing economic uses of bamboo. Many years ago in a district in the Bombay Presidency there used to be an area of about 500 square miles, extensively covered with bamboo forests, which had now disappeared owing to the large demand for bamboo for dwellings of the people. He thought those forests should be resuscitated and that no effort should be spared by the Government to this. Another important thing was fuel supply. Wood was in large demand in India, and the problem was how to get it for burning in the paper factories. Recently there had been discovered a means by which waste vegetation could be converted into solid fuel by the Wells' process which had been established in Egypt. Half a million acres of ground had been taken up there for cultivation, and the scheme was first of all to grow waste

vegetation to feed the machines which would convert it into solid fuel. For the purposes of transport, and other means, those machines would be of great use in manufacturing fuel from waste products around the paper-pulp factories; and he wished to point out what a great advantage the new process would be for India as regards obtaining fuel in this way.

Mr. Sindall, in replying to the vote of thanks, said that one or two interesting points had been raised on the general issue. He thought all were agreed that it was not a question of technical difficulty at all. The matters arising out of the actual treatment of the bamboo and the technical problems involved had been very largely settled. Nor were there any rival methods in use. As Mr. Baker had said, the whole question was one of £ s. d.—whether it was commercially possible. No private enterprise could possibly succeed unless there was a prospect of profit, and that was all the paper-maker or the pulp-agent was concerned with. With reference to the amount of bamboo available, the point raised by Mr. Ryan was an important one, because bamboo certainly had a distinct market value in the towns, and one would necessarily therefore be compelled to seek such regions in which bamboo was growing freely and where the cost involved was merely that of cutting down and collecting. It followed, therefore, that there would not be cultivation of bamboo as ordinarily understood, but a proper control of growth in areas allocated to or belonging to the mill. With respect to grasses, they were being used in large quantities by several mills. The difficulty with some of the grasses in India was that the yield was very low and therefore it was not a commercial proposition. The question of the suitability of bamboo in paper-making had been settled long ago. He supposed the reason why private enterprise had been rather backward in the matter was because it cost £100,000 to £150, 000 to put down even a small mill in an enterprise regarded as somewhat speculative.

## HIGHER FORESTRY EDUCATION.

It will be remembered that in a previous issue we reproduced a short account of the proceedings of the British Empire Forestry Conference which was held in London during July 1920. Not the least important of the subject discussed was that of Forestry Education. A special committee of delegates was appointed "to prepare a draft scheme of organisation of an institution which would provide for the following :—

(*i*) the training of forest officers for the United Kingdom;

(*ii*) the training of forest officers from parts of the Empire having no place of higher training of their own;

(*iii*) refresher courses for forest officers from all parts of the Empire;

(*iv*) special courses, some of which would be held at the institution and some at other schools of forestry of the Empire, with regard to which there would be interchange of students."

Considerable disscussion took place prior to the constitution of the committee but it was clear that the majority favoured the following two main principles :—

(1) That the training be carried out at one central institution.

(2) That a necessary preliminary of this training be a complete University education.

Some differences of opinion were found to exist in the minds of some of the delegates as to the relative advantages of this training taking place at a University and under its control, or at some place apart from and having no connection with a University. The committee appear to have been impressed with the importance of selecting forestry probationers with a view to securing the best type of officer for the Home, Indian and Colonial services and stated that the post-graduate standard denotes a definite stage in education at which point the work of selection by the Government concerned of the students most suitable for the service can be best achieved. After a full discussion of the pros and cons regarding the organisation of the institution, the committee

recommended the establishment of a centre apart from any University. The actual location of the central training institution did not fall within the terms of reference so this subject was not entered into either by the committee or by the conference.

The resolution of the conference in the matter of education reads as follows:—

"It should be a primary duty of Forest Authorities throughout the Empire to establish systematic schemes of forestry education. It has been found for climatic and other reasons that it would not be possible for each part of the Empire to establish a complete scheme of forestry education of its own, and therefore it is essential that those parts of the Empire which are willing and able to establish complete systems should, as far as possible, frame such schemes with a view to combining for meeting the needs of those parts which can only themselves make a partial provision for their requirements.

Part of this subject has been dealt with by a committee whose report, which refers mainly to the higher training of forest officers, is approved by the conference.

The main principles embodied in this report are as follows:—

(1) That one institution for training forest officers be established in the United Kingdom.

(2) That students be selected from graduates having taken honours in pure or natural science at any recognised University.

(3) That it be an integral part of the work of the institution to arrange supplementary courses at suitable centres for students requiring special qualifications and also special courses for forest officers from any part of the Empire, whether at the institution itself or at centres of training in other parts of the world. The Governments should recognise these courses as part of the ordinary duties of the forest officer, at any time during their service, and the Governments concerned should give special facilities to forest officers in their service to attend such courses.

(4) That a Department of Research into the formation, tending and protection of forests be associated with the training institution.

(5) Encouragement should be given to the existing provision made by Universities and Colleges for forestry instruction for those who do not desire to take the full course suggested for the forestry service. It appears that this is specially applicable to the United Kingdom.

It is also desirable to make adequate provision for woodmen's schools for the training of foresters as distinct from those which are intended for forest officers."

While the committee regarded selection at the post-graduate stage and severance from Universities as the ideal system of forestry training, it admitted that the important point of the actual relationship between the Universities and the training institution required further investigation and suggested its consideration by a committee at an early date. It is obvious that there may be very great if not insuperable obstacles in the adoption of an ideal scheme as the equipment of a separate institution with the necessary scientific and professional staff may prove, on financial grounds alone, too costly to be adopted.

An inter-departmental committee was appointed towards the end of last year and we have been favoured with a copy of its report, dated February 1st last. The members were Rt. Hon. Lord Clinton, Forestry Commission (Chairman); Rt. Hon. Viscount Novar, G.C.M.G.; Mr. P. H. Clutterbuck, C.I.E., C.B.E., India Office; Major R. D. Furse, D.S.O., Colonial Office; Professor J. B. Farmer, D.Sc., F.R.S.; Mr. W. H. Guillebaux, Forestry Commission (Secretary).

The terms of reference were as follows :—

"To prepare a scheme for giving effect to the resolutions of the British Empire Forestry Conference with regard to a Central Institution for training forest officers, including :—

(1) Its location.

(2) Its organisation, constitution and control.

(3) Its cost and method of financing.
(4) Its relation to forest research.
(5) The qualification, selection and cost of maintenance of students.

This committee visited the Universities of Oxford, Cambridge, Bangor and Edinburgh and interviewed representatives of other Scottish Universities and of interested institutions as well as a number of witnesses representing the forest services and the forestry commission.

After traversing the arguments in favour of a separate training institution the inter-departmental committee has arrived at the conclusion that as the Universities have recognised the necessity for an improved course of training and have, in some cases, enlarged and improved their curriculum, it would be a retrograde course to interfere with this step and it therefore recommends that existing University courses should be co-ordinated to bring them up to a common level and to utilise them as a preliminary to a higher course of training at a central institution.

The normal course of training at the Universities would extend to three years, at the end of which a diploma would be awarded to those who have attained the necessary standard. The complete University education as a preliminary to selection for the forest services is thus obtained in another way and valuable time is saved so that probationers could join the service at an earlier age.

Selection by the various Governments would take place at the close of the diploma course and it is proposed then to transfer these probationers to the Central Training Institution. At the latter the probationer would ordinarily specialise in two or more of the following subjects:—

(1) Forest botany and ecology in relation to British and Continental conditions.
(2) Advanced sylviculture in relation to British and Continental conditions.
(3) Principles of tropical and extra-tropical sylviculture
(4) Forest management (advanced).

(5) Technology and uses of wood and other forest products

(6) Forest engineering (including transport and conversion).

(7) Principles of commerce and accounts with special reference to forestry.

(8) British law and land tenure as affecting forestry.

(9) Indian forest law and land tenure.

(10) Regional forest botany.

(11) Mycology and pathology of trees (advanced).

(12) Forest entomology (advanced).

Other subjects might be included if necessary. It is recognised that in order to widen the field for recruitment and in order to obtain men with high scientific training a certain number of recruits should be selected with honours degrees in science. These would, after a forestry course covering the second and third years at a University school, spend a final year at the Central Institution. In order to attract such men it is recommended that a maintenance grant be given to cover the training subsequent to taking an honours degree.

In addition to the post-graduate training for the various services, emphasis is laid on the importance of affording opportunities to forest officers of following special or refresher courses which should be provided for at the Central Institution. The value of reciprocity between training institutions in different parts of the Empire is thoroughly endorsed. Thus India could offer valuable opportunities at a tropical Institution or under her Conservators for those who enter on service in the tropics and Canada could give instruction and demonstration in engineering and exploitation. The advantages of the closest possible relation between the Central Institution and research is obvious and the association of the two is recommended.

In determining the Location of the Central Training Institution the following alternatives were considered :—

(1) The setting up of the Institution as one of the schools of a University.

(2) Apart from a University either—

(*a*) Located in a University town or

(*b*) Located in the country at or near a forest.

The committee appointed by the Forestry Conference gave as one of its chief reasons for location apart from any University the necessity of retaining control over forestry education by an authority specially constituted for that purpose and it assumed that the acceptance of external control would not be tolerated by any University. Evidently this view was taken without sufficient enquiry as the University of Oxford has actually signified its readiness to accept a measure of control and has also declared its intention of extending its Forestry and Botany schools and is prepared to find accommodation for the Central Training Institution in these buildings and even offers temporary arrangements while the buildings are being erected. The University of Cambridge objected on principle to the idea of a Central Institution and Edinburgh recognised that a residential University should be selected. The choice therefore has fallen upon Oxford with the recommendation that the institution be incorporated with the University.

The control of the Central Institution is to be in the hands of a Board of Governors appointed as to one half by the Department concerned (*Colonial Office, India Office, Forestry Commission*) and as to the other half by the University. The Chairman of the Board would be appointed by the Department and the Director of the Institution, who is also to occupy the Chair of Forestry at Oxford and be a member of the Board would, with the staff, be appointed by the University.

Co-ordination of the University courses both in pure science and in the more technical side of the forestry education can, it is urged, be met by the formation of Delegacies or Joint Committees. While interfering as little as possible with the actual manner of education, equivalent standards are to be ensured by an approved curriculum and the results of the examinations. The common Delegacy, composed of representatives of the Universities and persons appointed by the Board of Governors, would make it its business to ensure equivalence of standard which would probably be best secured by the appointment of outside examiners. The principle, if accepted, is an excellent one and should lead to no difficulties in working out actual detail.

In the matter of finance a great deal must depend on the extent of the assistance which can be given by the University. It is proposed that maintenance charges, including interest and sinking fund, should be guaranteed by the Governments directly concerned up to an estimated figure. Payments would be made for students following the post-graduate course at a fixed rate, but if these payments fail to cover the total costs the deficit is to be made good by the contributing Governments in proportion to the number of students sent by each. The receipts from special or refresher courses would go towards the general revenues and these would serve to reduce the debit balance payable by the Governments.

It is suggested that the Director be assisted at the outset with one or more lecturers in sylviculture and management, also one lecturer in mycology and one in entomology. The cost of this staff at the commencement is estimated not to exceed £4,000 per annum.

It must, however, be borne in mind that the above brief outline merely sketches out the proposals and we must point out that the scheme has not yet been sanctioned.

We understand that the question as to how far India can co-operate in this scheme, if it be adopted, is under consideration and we hope to deal with this part of the subject in a later issue.

## INDIAN SPECIES OF CARISSA—II.

An article on the species of Carissa represented in the Calcutta Herbarium was published in the *Indian Forester* for July 1919. I am now engaged on the genus for the Flora of Bihar and Orissa and have examined the type specimens in the Herbarium of the Linnean Society which I had been unable to do when defining the species for the *Indian Forester* in 1919.

This examination has confirmed the name of *Carissa carandas*, L. (*loc. cit.* Plate 17, fig. 1) but has had the untoward result of determining that our common north Indian species, so long known as *Carissa spinarum*, does not exist in the Linnean Herbarium but that the species which Linnæus called *C. spinarum*

is the plant which Roxburgh afterwards named *C. diffusa* (*loc. cit.* Pl. 18, fig. 4)!

The description of *C. spinarum* in Willdenow's edition of The Species Plantarum of Linnæus is wrong inasmuch as he calls the plant a tree and it was this which has no doubt prevented botanists identifying the diffuse or scandent shrub called *C. diffusa* as the true Linnæan *C. spinarum* and which has also, where the identity has been recognised, resulted in the mixing up of the two species *C. diffusa* and our north Indian plant. But the specimens hardly leave any doubt and this identification of *C. diffusa* Roxb. with *C. spinarum* L. had already been previously noted by Dr. Stapf, Keeper of the Herbarium at Kew.

The identification, besides causing confusion in the well-known name of *C. spinarum*, has the further misfortune of leaving our best-known Carissa (hitherto called *C. spinarum*) without a name! In the Kew Herbarium indeed, Dr. Stapf has called our former *C. spinarum Carissa opaca* but in manuscript only and the name has not yet been published. The name is short and convenient and expresses the indistinctness of the nervation.

But in the *Indian Forester* the plant *Carissa paucinervia*, A.DC., is, at least so far as the plant so-named in the Calcutta Gardens (*loc. cit.*, fig. 3) is concerned, reduced to a variety of this our former *C. spinarum*, *i.e.*, Dr. Stapf's *C. opaca*. It will be observed that De Candolle's *C. paucinervia* is, at least in part, our north Indian plant as he quotes the vicinity of Benares and Monghyr as localities. Mr. Parker, who with myself has recently examined the Kew material of *C. paucinervia*, believes with me that it cannot be separated as a species. If this view is correct then our common north Indian 'kanuwan' will become *C. paucinervia*. If it be considered as a variety of the typical *paucinervia* it can be distinguished as variety *opaca*. But for those who prefer to separate species by more minute characters it could be called *Carissa opaca*, Stapf. It may simplify matters to tabulate the new nomenclature :—

*Carissa spinarum*, L. = *C. diffusa*, Roxb. = *C. spinarum* in part of Flora of British India = *C. diffusa* in part only of Brandis in

Forest Flora, p. 321 = *C. spinarum* in part only of Brandis in Forest Trees = *C. diffusa*, Roxb., Plate 18, fig. 4, *Ind. For. loc. cit*, and its variety probably (fig. 5 idem.). *Carissa paucinervia*, A.DC., var. *opaca*, = *Carissa opaca*, Stapf, ms. = *C. spinarum*, Lamk., and of *most other authors except* Linnæus = *C. spinarum*, *Ind. For.*, *loc. cit.* Plate 17, fig. 2.

H. H. HAINES.

# LAYS OF THE WESTERN GHATS.

## III.—THE KALI NADI.

There's a dark and tumbling River
In a district far away
Where the ferns and mosses shiver
On the boulders, black and grey.

Most Indian streams are muddy,
Not a few of filth are full ;
But the stately Kali Nadi
Lies like amber in the pool.

She starts in bosky evergreen
A sparkling rivulet,
And dashes down a gorge between
The Ghats and Jagalbet.

Then passes Supa bungalow
In wide and graceful sweep
To sparkle in the sun below
The Bhorkund, wide and deep.

And out and down a steep incline
Through forest dark and tall
Where lofty female bamboos line
The margin like a wall.

And on to Bomanhalli
See her silvery reaches set
Through plain and rolling valley
But all in jungle yet.

Till down below the Jamga slopes
And lonely Tamangi
She nears the palms and mango topes
Of Karwar by the sea.

There's a dark and tumbling River
In a district far away
Where my heart is turning ever
*And my fancies love to stay.*

For the Tapti's warm and muddy
And I long to roam in cool
Down the peaceful Kali Nadi
By some tiger-haunted pool.

GEM.

# EXTRACTS.

## THE EFFECT OF HEAT ON THE SOIL.

When a soil has been heated, it produces considerably higher yields than one which has not been so heated. This holds good for all non-leguminous crops. Darbishire and Russel (Journal of Agricultural Science, Vol. III, page 305) showed that soils heated to 95°C. in the laboratory produced two, three or even four times as much crop as a portion of the same soil which had not been so heated, and they conclude that the treatment had in some way brought about a considerable increase in the available plant food. One has only to compare the crop growing on a well burnt part of a "taungya" with that growing on any unburnt portion to be

convinced of the accuracy of this statement; but because the unburnt soil very frequently fails to produce any crop at all the difference *in the case of "taungya" cultivation is often much* greater than four to one. The reason for this is not difficult to comprehend when it is borne in mind that these investigators were dealing with fertile soils probably much richer in organic matter, lime and available plant food than our "taungya" soil. The former soil would at least produce a *crop by ordinary methods* of cultivation, whilst the latter, though physically fit, will seldom yield a crop worth the name by ordinary tillage alone.

Non-leguminous plants derive their supplies of nitrogenous food from the soil, and the production of ammonia in the soil *is mainly the work of micro-organisms which occur in enormous* numbers (from a few thousands to over 100 millions per gram of soil according to the character and condition of the latter). The organisms chiefly of interest here are those bacteria which produce ammonia by the decomposition of soil substances and the *nitrifying organisms which convert that ammonia into nitrates, in* which form plants as a general rule absorb their supplies of nitrogen. These organisms are present in all soils, and they multiply with marvellous rapidity when under favourable conditions. The rate of production of nitrogenous plant food is dependent upon the bacterial numbers present in the soil.

But Russel and Hutchinson (*loc. cit.*) have shown that bacteria are not the only micro-organisms which inhabit the soil, but there is another group of such organisms which are detrimental to bacteria and which considerably limit the numbers of the latter. The second group is believed to be the protozoa—low forms of animal life with microscopic, jelly-like, unicellular bodies. Three main families of these protozoa have been identified, *viz.*, flagellates, ciliates, and amoebae, and it has been shown by Buddin and Cunningham as well as by the investigators named above, that when these are present the numbers of bacteria and consequently the production of ammonia are seriously restricted. The organisms, both bacteria and protozoa, occur principally in the surface of soil—say, in uppermost six inches.

These protozoa are larger than the bacteria, but fortunately they have not only lower powers of resistance to heat and to antiseptics but their rate of multiplication is lower. They are more readily killed by heat than bacteria are, and they multiply less rapidly—phenomena only recently discovered but of which the "taungya" cultivator appears to have taken advantage for hundreds of years.

The effect of heat upon a soil in the direction of increasing the plant food may be regarded as twofold. The immediate effect is to render soluble by chemical decomposition some of the nitrogenous substances found in the soil. Ammonia is produced, and the higher the temperature the greater may be the amount expected; but if the temperature reached is high, much organic matter is decomposed and loss occurs. The nitrogenous plant food produced in this way, directly by heat, is available for the use of plants, but it very rapidly disappears, and the influence on plant growth on this account is of short duration. But another more durable though still a temporary effect is to be found in the action of heat as a sterilising agent.

When the soil is heated to moderate or to high temperatures, large numbers of the micro-organisms are destroyed. The protozoa, being less resistant to heat than the bacteria, are killed first. The nitrifying bacteria are also fairly easily killed and generally perish at moderate temperatures, but the organisms which decompose soil substances to produce ammonia are more resistant. Besides which bacteria produce spores which strongly resist heat and afterwards on the addition of moisture, will germinate and multiply very rapidly in the absence of their enemies, the protozoa.

Thus it happens that when a soil is partially sterilised by heat, the detrimental organisms are killed, and though most of the bacteria may also be killed, there are sufficient left to multiply when conditions of moisture and temperature again become favourable. With their enemies removed they do this at such a tremendous rate that within a few days they have reached the original numbers, and within 3 or 4 months they will have

increased to several times the original numbers. Russel and Hutchinson, in their investigations referred to above, have quoted cases 60 to 120 millions of bacteria per gram of soil in three to four months' sterilisation.

Generally speaking, the higher the temperature reached the greater will be the destruction of bacteria and the slower the recovery of the number until at about 120°C. all are killed; *but in order to destroy all the protozoa it is necessary to raise the* temperature above 55° to 60°C. At that temperature all the number of bacteria is moderately reduced and the recovery is rapid. In fact the maximum bacterial numbers are afterwards obtained when soils are heated to about that temperature. This seems to throw a glimmer of light on the cultivator's preference for smouldering fires and moderate heat. Even at the low temperature of 40°C. maintained for some time, the detrimental organisms suffer very considerably; and thorough drying, such as *most of the soils in this country are annually subjected to*, temporarily suppresses their action.

The destruction of the nitrifying organisms, along with the protozoa, is not such a serious matter as might be supposed. It does not "seriously interfere with the growth of plant—as a matter of fact it seems to have but little effect; plants readily take up the decomposition products, ammonia, etc. Nitrification is shown to be economical but not essential. The excess of nitrogenous plant food in the partially sterilised soil soon becomes *so great that it causes a correspondingly vigorous plant growth.*" Moreover as in "taungya" burning, only a portion of the soil is heated enough to destroy all the organisms; these latter are introduced when outside soil is mixed with the other. They immediately begin to multiply at much greater pace than their enemies which are re-introduced at the same time.

Now the result of introducing untreated soil into partially sterilised soil is to still further increase for a time the bacterial numbers and consequently the production of ammonia and nitrate. *This is easy to understand when the relative rates of multiplication* are borne in mind. The rise in numbers of bacteria is sustained

for a considerable time; but after a while the detrimental organisms which have also been recovering their numbers, though at a less rapid rate, begin to make their influence felt, and there is a depression in the bacterial numbers until the original equilibrium between the two groups of organisms becomes established. When this takes place, the soil will have returned to its original state in respect to plant food being produced by bacteria.

To reiterate, the effect of heating is an initial and considerable increase in the quantity of ammonia present in the soil. This direct effect disappears before long, but it is followed by a rise in the rate of production of ammonia by bacteria, and consequently in the productiveness of the soil. The latter, or indirect effect of heating due to partial sterilisation, may be sustained for a considerable time. It does not begin until the dry soil becomes moistened by rain, because bacterial (or protozoa) multiplication or activity cannot proceed without moisture, and it is checked or even stopped entirely when the soil becomes dry again.—[*Agricultural Journal of India, Vol. XVI, Part III.*]

## TAUNGYA CULTIVATIONS.

SIR,—In the July *Indian Forester* you publish a resumé of an article from the *Scientific American* on Taungya cultivation as applied to Forestry, which contains some misleading statements. It says, "It should be emphasised, however, that Taungya cultivation can only be considered on comparatively flat land and that in the case of sal the absence of frost is almost essential to success." The former of these statements is opposed to fact and the second is not at all certain. In the neighbourhood of Kurseong and Mongpoo there are fairly extensive taungyas in the Himalayas not on the steepest ground it is true, but on ground which is far from "comparatively flat."—In Dehra Dun where frost damage is severe everywhere sal has been raised with *Cajanus indicus*,—the sal on cleared lines 3 ft. and 4 ft. wide with lines of Cajanus between, and frost damage was very largely diminished. The average frost mortality in the first winter was only 12 per cent. the sal being 8 ins. to 1 ft. high at one year old. After four years of frost the *total* mortality from all causes calculated on the original germination was 32 per cent. If the 3 ft. lines are excluded—where the mortality was probably due more to the dense shade of the Cajanus than the frost, the total mortality from all causes after four seasons frost was 23 per cent. and at 4 years old the sal averaged some 4 to 5 ft. in height. It is true the experiment needs repeating on a larger scale to make the result certain but it is rather premature to rule out the method yet. Whatever few indications there are point rather to the probability of success.

S. HOWARD,
*Silviculturist.*

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# INDIAN FORESTER

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## GENERAL NOTE ON FUTURE OF DEPARTMENTAL EXPLOITATION IN THE PUNJAB.

### I.—*Importance and Magnitude of Work Undertaken.*

During my recent tour through the forests of the Punjab which lasted from May 29th to November 9th, there were a few outstanding impressions and conclusions that were of too general a nature to include in reports of any specific district and of an import that would apply only to the general administration of the Punjab forests.

*First*, was the magnitude of the operations, if carried out up to the productive capacity of the forests. While starting in a comparatively small way using the present organisation of the Forest Department as a managing and producing factor, it must eventually expand into a very large business, employing thousands of men directed by a separate, specially trained staff. The present personnel of the Forest Department is now very short of trained men to carry out its own work in silviculture and

administration of the forests. The expansion of the exploitation areas is going to make a great deal more work for the trained men of the Imperial Service. Every recruit they get during the next five years will be urgently needed for their own operations in silviculture, protection, and management.

## II.—POSSIBLE METHODS OF MANAGEMENT.

Therefore two courses of procedure seem to be open to Government in respect to obtaining the fullest utilisation and greatest revenue from its forest resources.

1. First they may operate the various exploitation schemes in a purely departmental manner.

To do so will mean the gradual training and organisation of a separate Exploitation Staff. This training will have to extend from that of highly trained forest engineers and exploitation officers down through the entire subordinate staff. Courses in Forest Engineering will have to be installed in the principal forest schools and engineering colleges and shorter courses of practical training will have to be offered in the various localities where exploitation work is under way for the subordinate staff. In importance and scope this undertaking will be second only to the building up of the present Forest Department which has taken many years of painstaking effort.

The success of exploiting the forests will be greatly jeopardised by a number of factors inherent in any purely governmental organisation. These consist: *First*, of the inability to purchase supplies through an agency, expert in the problems arising from the use of special tools and machinery. *Secondly*, in getting quick delivery of such supplies and of having suitable reserve stocks in convenient centres in case of emergencies and breakdowns. *Third*, through the inability of the men who manage the different operations to get the fullest efficiency from their men by reason of limited powers in hiring skilled men, in dismissing incompetent men, and in recognising special ability in subordinates by quick promotion and increase of pay when deserved. Without such incentives to special endeavour the best

type of men cannot be secured. *Fourth*, the necessity of having all important and many unimportant decisions go to some higher usually non-resident authority for sanction, many times this higher authority being uninformed of local conditions affecting the matters under consideration. This, in turn means a large amount of official correspondence which takes an undue amount of time from the more urgent duties of the managing officer. *Fifth*, the piling up of clerical and accounting work through lines of procedure built up under past conditions which are entirely non-existent in respect to the conduct of a purely commercial operation.

2. To meet the above-mentioned problems we must work along one of three possible lines of procedure :—

(1) For Government to enter into a limited partnership with reliable and efficient private firms who would undertake the commercial working of the forests under Forest Department supervision.

(2) To form Government financed companies which would be run along commercial lines under a board of directors composed of Forest Department officials, a finance member of Government, and representative business men. All profits to be retained by Government except such sums as would be needed to enlarge and efficiently conduct the enterprise.

(3) To organise a Forest Engineering and Exploitation Service which would work as an integral part of the Forest Department and be under the definite control of the Chief Forest Officer of the Province.

3. The first of these plans would undoubtedly meet with bitter opposition politically and would be constantly subject to political attack. It would also offer many chances for friction in allotting the percentage of profit due to Government and to the private capital.

The second proposition might be practicable, given the right men as directors and an able and well trained manager. It offers however many debatable features and would depend largely

for its success on the men chosen to direct it and freedom from political interference.

So in a last analysis it seems to me that we must rely on the third proposal in order to get a start towards the full development of our forest resources.

There will be many handicaps due to precedent and such as are inherent in developing a new and comprehensive organisation. On the other hand if the organisation is worked out along sound lines many of the objections to Government operation can be overcome.

III.—Organisation of Exploitation Staffs.

There is a great need at present of a systematic organisation of the exploitation staffs in the different Punjab divisions along a well defined plan. Due to the sudden change from selling the timber on a royalty basis to one of departmental working, each divisional officer was left to work out his own salvation as best he could. The result has been that in each division a separate type of organisation is being developed. In each the staff is composed of different units bearing varying titles, with different duties to perform, and on differing pay. So in one place we have an Exploitation Officer on Rs. 800 a month, in another with varying duties the exploitation officer is called an Exploitation Assistant and received pay varying from Rs. 300 to Rs. 600 per month. The same thing applies to the subordinate staffs. A supervisor in one division may have different duties and receive different pay from a supervisor in a neighbouring division.

This is a condition of affairs that is bound to make trouble. Sooner or later this work must be standardised in localities where the problems are similar. The sooner a definite plan of organisation is adopted the less difficulties will be encountered in putting the new plan in force.

Hence I would suggest that a conference of the forest officers involved be held, out of which could come a well defined plan of organisation which would be suitable to all divisions. This conference should include the men who have been getting experience along exploitation lines, namely, the Divisional Forest

Officers and their chief exploitation officers, together with the Conservators of the two Circles.

In this connection I would suggest that the Deputy Conservator of Forests for Hazara District, N.-W. F. P., be included, as his problems are identical with those of the Punjab hill divisions. Also he has developed an exploitation staff in much greater detail than have most of the divisions. I cannot but believe that the united experience of these men who have been actually dealing with these problems would produce a practical working organisation that could be applied to all hill divisions.

### IV.—Forest Engineering.

Another outstanding fact that has made itself very apparent during my tour is the need of more trained forest engineers than will be available from the men now in training in the United States. At present as I understand it, the Punjab is to get two of these men and Hazara one.

In addition to these three men there is urgent need of two experienced men in the Rawalpindi Divisions and a second man for Hazara, in order to inaugurate the new schemes for working the forests. All this has been discussed in more detail in notes on the separate localities.

The point I wish to make in regard to the Punjab as a whole is that there must be one forest engineer of *proved* ability and experience to co-ordinate the work of the different divisions and to direct the efforts of the younger engineers who are coming out to a new field to undertake very important work after a short period of training. Most of these men will no doubt make good, but they will need the experience and help of an engineer who has been engaged in this line of work for a number of years, in order to give them a fair opportunity to surmount the unusual conditions of their work in India. As most of the work will at first consist of laying out and constructing the transport lines for large logging operations, any mistakes that may be made will not show up for some time. When they are discovered it usually means a very considerable financial loss as all the schemes recommended depend very largely on the engineering

skill used in designing and laying out the slides, flumes, dams, etc. A logging engineer is supposed to have four years of specialised university training and four or five years of practical experience before he can be considered as well grounded in his profession. These men have only been allowed a little over a year of special training. For the first three or four years in India they are going to be overburdened with work. They must demonstrate just how each slide or flume is to be constructed and teach the mistris and coolies in all details. Besides there is an immense amount of preliminary surveying to be done and new organisations to be built up. Under the direction of a chief engineer they will be relieved of a considerable amount of this responsibility as he can formulate the general lines of work to be undertaken and can check up results at intervals.

The chief engineer's office would also have the preparation of all general plans and specifications for different structures recommended. To give some instances :—

(1) Suppose an overhead gravity ropeway is specified in a certain location. The chief engineer's office would have blue prints made of all devices needed, such as lowering drums, detailed plans for erection, etc. As this would be a combination of different lowering devices to meet Himalayan conditions it would be new and not manufactured as standard equipment. Therefore drawings of all parts would have to be made and submitted to various firms in India for the making of the component parts. Once perfected and recommended for several divisions, these divisions would also be furnished with a blue print showing all parts, which would be numbered and listed. They would also be informed where this equipment could be had and at what price. The officer in charge of the work could then order direct from his blue print any parts needed. As all castings and blocks for this equipment would be made by one firm, the volume of orders would tend to cheapen the product. Unless the officers in charge do know where the equipment can be secured and are assured it will be what they want they are absolutely helpless in trying to get parts made through correspondence.

A case in point is that of the parts for a controlled slide to be erected in Bashahr. The plans were submitted to a number of mechanical engineers and to several firms before they could be reduced to a practical working basis. Eventually the whole equipment will be carried by one firm in Calcutta which will have blue prints corresponding to those furnished to officers in the field. Hence as these devices have been recommended for many forests, there will be no difficulty in procuring the desired parts on short notice.

(2) Again, suppose a "crib construction splash dam" is recommended for a certain stream Unless detailed plans and specifications for such a dam can be furnished by the chief engineer's office, the local officers, who probably have never built such a structure, will be at a considerable loss to know just how to go about erecting and operating it.

(3) Then three types of pole or stringer roads are specified in certain districts. There will be three standard designs of log carriage to be used. Unless such castings and carriage are standardised we would have a slightly differing type for each operation with the corresponding higher expense of getting the parts made.

(4) At the present time there is at least four months of steady work for a competent mechanical draughtsman on hand in drawing up such designs. The local officers have not the time for such detail work, nor will the new logging engineers. It should all be done through a centralised engineer's office.

The same arguments apply to slides, flumes, and various other types of construction recommended.

## V.—Results to be Expected from the Full Utilisation of Forest Resources.

Given a scheme under which the forests may be worked to their fullest capacity under scientific forest management, we may expect the following results :—

1. A very large increase in revenue This should run from double the present revenue to ten times the amount now returned from the forests. The difference in increase depends largely on

the possible volume of timber produced in the different forests annually and on the ability of local and foreign markets to absorb the outturn. As the timbers become better known and as methods for seasoning and treating them are perfected a greater proportion of the timber crop will be made marketable and proportionately greater returns will be made available.

2. The conditions of the forests will be greatly improved, as under scientific treatment the gross yield per acre will increase and the proportion of valuable species will be made greater. Under present conditions it is often impossible to get the best silvicultural results in the forests because so little of the product can be utilised and the expense of disposing of this waste product is too great to permit extensive silvicultural operation. By concentrating the exploitation of timber the regeneration work may be concentrated at a great saving in supervision and making close inspection of work done possible.

## VI.—Conclusion.

The whole problem is one that requires patience and hard work. We must train men, create organisation, bring into use new tools and equipment, and provide for the manufacture of such tools and equipment in India as may be possible. In the end it will mean a very considerable business development and will benefit the country in a very substantial way. Without these rather disturbing changes the country can never make the most of its wonderful timber resources.

These things cannot be done in a day or a year. But by continual, well thought out effort, a great transformation can be brought about in ten years time which will be of inestimable benefit to the country and to the people. It will not be "exploitation" but a fuller utilisation of one of the greatest of natural resources while improving the forests both as to extent and yield.

C. S. Martin,

*Consulting Forest Engineer to the Government of India.*

# NATURAL REGENERATION.

"Instead of the thorn shall come up the fir tree.
Instead of the briar shall come up the myrtle tree."

In an earlier essay it has been shown that the foundation of all good forestry lies in the intense study of nature, dominated by a love of trees and a desire for knowledge. Approached in any other way silviculture becomes a tedious task to be delegated as far as possible to ignorant subordinates, with the usual deplorable results. Without an inborn appreciation of the growth of trees no one can become a master of this art. Without a master's skill no system of management can reach perfection. In the processes of natural regeneration the art of silviculture reaches its zenith. Every tree differs in its requirements, every aspect and species requires different treatment. Here a group of advance growth is retained and freed to form part of the future crop, there existing saplings are cut away as undesirable.

Three factors govern the successful regeneration of a forest crop :—

(1) Soil.
(2) Light.
(3) Moisture.

All these factors are interdependent, they must exist in suitable harmony one with the other and when these conditions are fulfilled natural regeneration follows as a matter of course.

The art of the forester in this branch of his work consists in developing his practice so as to bring about this happy state of affairs as far as possible by the usual processes of nature.

The first factor that must be suitable is the soil, that is to say the chemical, physical and biological conditions of the soil must all be favourable. Every forest soil probably contains the limited quantities of nitrates, phosphates, lime and potash necessary to plant life. The availability of these chemical substances will largely depend on the physical properties of the soil. Excess of such substances as humic acid in the soil is very prejudicial to plant growth, but such excess is due to physical causes which can

be overcome by good husbandry. Adverse physical soil conditions may be ameliorated, stiff clay will be improved by the maintenance of a close forest canopy over a series of years and the consequent admixture of humus with soil followed by suitable cultivation. Similarly a light sandy soil can be improved by the natural adding of decaying vegetation which will increase its water holding capacity.

If suitable physical conditions cannot be obtained by the proper manipulation of the canopy, then more drastic steps must be resorted to and the surface soil stirred up to produce a good tilth and to amalgamate the humus with the mineral soil. Finally in order to obtain abundant natural regeneration the bacterial flora of the soil must be prolific and the process of nitrification active. A soil in good heart will naturally be well aerated and will contain an active bacterial flora. Given active nitrification in the soil, obtained no matter how, natural regeneration presents no difficulty. Henrik Hesselman has shown in the reports of the Swedish Institute of Experimental Forestry, that a lively nitrification in the ground is essential to profuse reproduction. His researches have shown :—

(1) In the fairly dense mixed coniferous forests of central Sweden, where the ground covering consists mainly of moss, clear cutting, shelterwood cutting or merely chequerboard cutting can produce lively nitrification.

(2) The preparation of the soil with the Finnish plough or any other machine that causes a mixture of the humus covering and the mineral soil produces a formation of nitrates, even when the wood is so dense that nitrification does not otherwise occur.

(3) Mouldering brushwood and old rotting timber require or produce nitrification in the ground, even under circumstances in which the formation of nitrates does not occur on the clearings.

(4) Where the covering of raw humus is somewhat more developed, chequerboard cutting, shelterwood cutting or clear cutting does not by itself produce a formation

of nitrates. The formation of ammonia, however, is substantially increased. But the formation of nitrates can be produced either by a preparation of the ground with machines or by the burning of brushwood.

His conclusions are summarised as follows:—

"If we go through our experience of the factors that favour regeneration, we find throughout that in a very notable manner they coincide with the nitrification of the humus nitrogen. Where the nitrogen of the humus covering is transformed into nitric acid the regeneration proceeds easily and the young pine and spruce plants develop, well provided they do not have to compete with an uncommonly luxuriant grass and herb vegetation. Where the nitrogen of the humus covering is not nitrified, natural regeneration is rendered difficult and the spruce and pine plants grow slowly."

Hole has shown that proper soil aeration is absolutely essential for the full development of sal seedlings and by soil aeration he implies an adequate supply of oxygen in the soil. The researches of the Agricultural Experimental Station of Cornell University have shown that vigorous nitrification takes place in sealed flasks as long as there is supply of oxygen and that there is an optimum mixture of this gas (one containing 35 to 60 per cent. of oxygen) for nitrification. Further "when the supply of oxygen becomes limited and anaerobic conditions are produced, denitrification sets in and this continues until practically all the nitrates are destroyed." Therefore it is clear that all these factors of the soil are interdependent one on the other. Without a proper supply of oxygen active nitrification will not occur and where the latter condition is not fulfilled adequate regeneration will not take place. We have already seen the conditions under which nitrification can be increased in coniferous woods by ordinary forest operations.

The Dehra Dun experiments of Hole have further shown that when rain-water rich in oxygen is held in contact with ordinary

forest soil, the oxygen is rapidly exhausted and the supply of $CO_2$ is increased. An increase in the $CO_2$ dissolved in the soil water necessarily means an increase in soil acidity detrimental to active nitrification. He has also proved that a water culture solution containing an excess of $CO_2$ and a deficiency of oxygen has a directly toxic effect on plant roots. The advocates of the soil toxin theory also have shown that such toxins cannot exist under conditions which bring air, and therefore oxygen. into contact with toxic solutions.

The extent to which nitrification is going on in the soil is frequently apparent from the vegetation found on the ground. In Sweden Hesselman states: "Where the humus nitrogen is transformed into nitrate, there appear nitratophilous plants such as raspberry, *Epilobium angustifolium*, *Arenaria trinervia*, etc." In Kulu, Trevor writes: "There can further be no doubt that the presence of shrubs and plants of the natural order Leguminosæ is especially desirable and the presence of *Indigofera Gerardiana* has been observed to improve the vigour of young deodar growing in its vicinity." In Kulu a growth of raspberry and Indigofera follows a fire, indicating active nitrification, and profuse regeneration of pine and spruce is frequently a feature of such old burns.

It may safely be said that an excessive deposit of needles is inimical to the regeneration of all coniferous trees; indeed the same thing has been found in the Kelheim State Forests of Bavaria and is well known in Kulu, in both places steps are taken to get rid of this deposit. Seed germinates readily in this loose humus, but the seedlings cannot survive the hot weather in May and June; their slender roots cannot penetrate down to the mineral soil and consequently with the drying out of this raw humus they perish. The effect of clean mineral soil in stimulating regeneration is well known.

Collier states regarding sal in Haldwani: "The other factor is the condition of the soil and by the term soil is signified the surface soil which is solely concerned in the question of reproduction. There is much evidence to show that a soil of loose texture particularly and of good physical qualities generally is

very receptive to regeneration. Results of the experiments with soil wounding indicated that regeneration may be procured in great quantities on a fresh soil."

In order to produce conditions of soil suitable for the regeneration of sal Collier propounds the system of burning the ground leaf cover after the fall of the leaves in March, more especially when a good seed year is expected. To any one acquainted with the leathery nature of the sal leaf and with the struggles of the seedling root to penetrate this almost impermeable stratum in order to reach the mineral soil, the advantage of this procedure will be obvious.

This work has been done experimentally over considerable areas in Ramnagar and Haldwani and this combined with the admission of sufficient light, in accordance with Hole's researches, is at present the foundation on which a system for the natural regeneration of sal is being built up.

In the case of the Himalayan conifers Trevor has standardised the methods of soil preparation to follow the first seedling felling, having come independently to exactly the same conclusions regarding excess humus which Hesselman has now proved to be correct. His method is described as follows:—

"After the completion of the first regeneration felling all rubbish, bushes, inferior trees, raw humus, exploitation refuse and suppressed advance growth will be collected and burnt, and the soil placed in a suitable condition to receive the seed. This may necessitate hoeing with the pronged vine hoe already in use."

The collection of the exploitation refuse is done by hand labour, the larger branches are thrown on to piles and the smaller chips and the raw humus raked up with iron pronged rakes and the whole burnt in small heaps. A wonderful reproduction frequently follows this treatment.

All practical methods of obtaining suitable soil conditions have now been dealt with. It is not only necessary to obtain this ideal in the first instance to admit of complete germination and early growth, but in the case of sal equally important to maintain suitable conditions so that the establishment of the seedlings may

be obtained at the earliest possible date and the period of dying back largely reduced or done away with entirely. This natural dying back must be due to various factors unfavourable to growth, as under garden conditions with perfect soil, full light and sufficient moisture, sal does not die back at all and develops straight away into healthy saplings. This supposition is still further supported from an examination during the monsoon rains of sal regeneration under a fairly heavy canopy and a dense soil covering of decaying vegetation. In spite of a superabundance of moisture and heat generally considered favourable to growth, the sal seedings were in a most miserable condition and it was self-evident that they were growing under some unfavourable condition of soil, light or moisture. Research is now being made to discover exactly what this adverse factor is so that theprocess of regeneration may be modified accordingly. How important this matter is may be realised from the fact that sal regeneration eight years old which has received constant attention and yearly weeding does not as yet show any sign of upward growth.

Granted suitable soil conditicns the next factor necessary for successful regeneration is light. The varying light requirements of species are well known and sufficient importance is devoted to this matter in text-books dealing with European forestry. But in India in the case of many species considerable doubt still remains as to the conditions of light suitable for their reproduction.

Light and moisture are intimately bound up. Side shade from the south for instance may be responsible for a more or less constantly wet soil and is often the injurious factor in such cases rather than a deficiency of light rays for photosynthesis. Light is therefore in this essay used as a relative term meaning not merely " light " such as is measured by a photographic exposure meter but in addition the inseparable factors of soil and moisture conditions which are directly caused by fellings in the overwood for the purpose of admitting light to the soil.

In the case of the deodar it has been stated that this species is a shade bearer but this is not so. Many years of investigation

into this matter have brought out exactly what are the light requirements of this tree.

"Deodar germinates under all conditions of light and shade but the time soon comes when seedlings growing in shade must be given plenty of light if they are to survive. It has been stated that the group system is suitable for the deodar, but this system is only suited to a shade bearer, and so far from falling into this category the deodar must be classed among the light demanders. A gap 100 by 80 feet with seed bearers around, clear felled, S. W. aspect, 6,000 feet elevation, was completely regenerated in 1914 and promptly fenced. Vigorous seedlings now survive in the upper half which received most of the light, but in shady places round the edges they have all died away. We have thus in the experiment eliminated every cause except the factor light, and it is want of this alone which must have caused the death of the seedlings. Another somewhat similar group in a different locality confirms this observation; and a comparison of group and shelter-wood fellings is entirely in the latter's favour. Innumerable instances can be given of the influence of light on growth; in the Jutlikawala plantation the height of deodar growing in the full enjoyment of light was double that of plants growing under only a light overwood of Kail."

Similarly in the case of spruce, which is reputed to be a moderate shade bearer, it has been found that this tree in the Himalayas is not a shade bearer at all but requires as much light for its reproduction as the deodar. Troup has aptly summarised the light requirements of the chir pine as follows :—

"The chir pine is one of the most light demanding of species and under favourable conditions the more light admitted the more successful and complete will be the regeneration. It may be said that in ordinary favourable circumstances 5 to 8 good seed bearers per acre are ample for affecting regeneration; and that a greater number are not only unnecessary, but may even be detrimental to the establishment of a healthy young crop. This statement however should not be taken to apply universally. Thus on hot slopes where the soil is stiff and the seedlings are

liable to suffer from insolation, protective shade is essential; and the demand for such protection may outweigh the demand for light. There are instances in the Rawalpindi division, where the slopes are hot and the soil is clayey, of good reproduction establishing itself under an almost complete canopy. We may, therefore, qualify the general statement made above by saying that where protection against drought is necessary the number of seed-bearers per acre may have to be increased very considerably; it may also be stated that on southern slopes as a rule a larger number of seed-bearers are required than on northerly aspects.

Opinions regarding the light requirements of the sal still differ. Collier writes regarding the natural regeneration of this species under the shelterwood compartment system in Haldwani.

"The whole process of the regeneration of a wood can therefore be divided into three stages :—

(*a*) Regeneration may be obtained without any felling of the overwood or cleaning of the underwood. There is no evidence to show whether the excellent regeneration which occurs in areas which have been heavily felled over in the past was present before the fellings were made or ensued as a direct consequence of the fellings. But even if healthier seedlings are produced under a light overwood and little or no underwood it would still be inadvisable to open out the cover in anticipation of a seed year. If a successful regeneration year followed the fellings and cleanings immediately excellent results might be obtained. But if no seed year occurred for several years the exposed and fresh soil would most certainly deteriorate and become stocked with grass so that future attempts to procure regeneration would be difficult. Since it is quite certain that plentiful reproduction may be obtained under the most adverse conditions of light the safest method of treating an unregenerated area is the maintenance of a complete overwood and underwood and the burning of the leaf layer. It may be also noticed

that the overwood in these selection forests is rarely dense but is generally in a condition resembling that of a European overwood which is in the state of a light seeding felling.

(*b*) On the appearance of seedlings some degree of light should be admitted by the removal of a portion of the underwood and overwood. It is very important that this admission of light should be gradual since it has been noticed that seedlings which have germinated and spent their first growing season in shade tend to wither if too suddenly exposed to direct sunlight.

(*c*) Over established reproduction the overwood can hardly be felled too heavily except in areas in which the possibility of frost damage prohibits the absolute clearing of overwood over too wide areas."

On the other hand Hole's researches go to show that the sal seedling requires full overhead light for its proper development. These opposite doctrines must somehow be harmonised and a silvicultural system for the natural regeneration of sal worked out. This investigation is now well in hand.

Blanford has also shown in dealing with the teak in Mohnyin (Burma) that burning of the soil covering and intense light are necessary for the natural regeneration of this species. He relies on the seed already dormant in the soil for his reproduction and clear-fells the whole of the overwood. Hole's experiments at Dehra also confirmed this silvicultural fact.

In all methods of regeneration under a shelterwood it must be remembered that two diametrically opposite considerations have to be compromised—(1) the necessity for retaining sufficient trees to keep down the growth of weeds and to produce an ample crop of seed, at the same time sheltering the young growth from drought, frost or hot winds; and (2) the necessity of removing all cover not absolutely necessary, so that the subsequent fellings of the overwood will do as little damage as possible to the young regeneration.

A compromise is therefore necessary and in the exact degree of compromise lies the art of the forester.

The different light requirements of different species in a mixed crop may be used by the skilful forester to manipulate the proportion of species in his new crop. This is done in Europe with the spruce and the silver fir; the same idea has been employed by Trevor in the regeneration of a mixed crop of deodar and blue pine.

"It is only necessary to make a first seeding felling suitable for the reproduction of deodar; and thereafter to lighten the overwood so that Kail seedlings complete the crop."

It is thus apparent that an exact knowledge of the silviculture of trees is absolutely essential if success is to be obtained in natural regeneration. Given this knowledge it is perfectly easy to devise a system of management in concordance with the silvicultural peculiarities of the tree and the nature of forest being dealt with. Even treated under different systems of management the fundamental silvicultural requirements of the species must still dominate the technique of regeneration. The management of chir pine, blue pine, and deodar under the shelterwood compartment system has now been standardised. Work on these lines is being carried out for sal, spruce and silver fir and the regeneration of teak with clear felling is well understood. Much still remains to be learnt, but once systematic attempts are made to regenerate a definite area with some definite species, results will be obtained in due course by any careful forester.

The correct treatment of the soil and the correct admission of light are both within the competence of the forester, but the third factor moisture can only be influenced by him to a moderate degree.

It has already been shown that the character of the fellings will influence the moisture conditions of the soil and to this extent the latter factor can be controlled by the forester, but acts of God such as unusual prolonged droughts are beyond his control and the losses they cause must be accepted as inevitable. Similarly no silvicultural technique can do away with the hazard of hail-storms which may ruin delicate seedlings.

It has been supposed by some that a dense canopy of mother trees prevented seedlings from dying of drought. As a matter of fact the reverse is the case; deodar seedlings under dense shade have actually died of drought while seedlings growing in the open have continued to flourish. Under heavy shade there is no dew, whereas in the open there is plenty; a slight fall of rain has no effect on plants growing in the shade whereas those in the open obtain the benefit of every shower. For these reasons all low spreading branches are pruned off the deodar mother trees as a routine measure in areas under regeneration. While heavy shade is injurious to the regeneration of all species other than dense shade bearers such as silver fir, a moderate amount of high shade, more especially side shade to ward off the hot sun, is beneficial and in some cases absolutely necessary.—" In the hills, on south, south-east and south-west aspects the difficulty of obtaining regeneration is much increased and on these aspects the necessity of side shade to the young plants must be kept in view. " It is believed that the constant soddenness of the ground during the rains under a fairly heavy canopy of sal trees is most injurious to sal seedlings and that this evil effect would be mitigated by a heavier felling in the overwood and the admission of more sun and air to the ground. Excess of damp is also fatal to deodar, under such circumstances the seedlings fade away or are destroyed by a fungus believed to be *Peridermium*. In areas of deficient rainfall moisture can be conserved by soil cultivation but this belongs more to the province of sowing and planting which will be dealt with in a subsequent essay.

The principles of natural regeneration are of world-wide application, the skill of the forester lies in adapting these principles to a multitude of different species or to a mixture of species growing in the same crop; in manipulating the canopy of the mother trees so as to obtain regeneration of such species and in such proportions as he may desire and at the same time to restrain a superabundant growth of weeds.

It is not sufficient to obtain complete germination; this is only the first stage towards success. The young seedlings have now to

be nursed up to the sapling stage. Weedings will be in many cases absolutely essential and on the thoroughness of this work success will often depend. This dense weed growth in a clear felled area will absolutely destroy untended teak seedlings and the same is true of moist coniferous forest where only a moderate opening of the canopy produces a crop of herbs which will effectually smother any young tree. In most cases a certain amount of sowing and planting will be necessary to complete natural regeneration and there should be no hesitation in carrying out this work to such extent as may be necessary. In Kulu after burning the slash it is a routine measure to sow up the burnt heaps with deodar seed and the results are magnificent. Surplus plants are removed from these heaps when 1½ years old and planted out. Every endeavour is made to complete the regeneration in as short a time as possible, as every year that passes after the execution of the seeding felling makes success more difficult and expensive. Artificial sowing and planting is also necessary when it is desired to increase the proportion of a valuable species in a mixed crop and this cannot be effected by natural means. French forestry inclines perhaps too much to natural regeneration and German practice to artificial planting. The happy mean between the two schools will give the best results and the good forester will aim at getting the bulk of his new crop by natural means and should then not hesitate to assist nature to his utmost ability by completing the crop artificially. Working on these lines very considerable success has been obtained, and as time passes it is hoped that more and more attention will be given to the various silvicultural operations which are necessary to obtain natural regeneration, that research will indicate to us the correct treatment of the soil to ensure a complete reproduction and maintain this in health and vigour, and that the light requirements of more and more of our principal species will be elucidated and their methods of natural regeneration standardised.

The young seedlings will now be growing up and in the next essay their]subsequent treatment will be dealt with.

"TROWSCOED."

## HIGHER FORESTRY EDUCATION.

The *Gazette of India* of August 20th, 1921, contains Government of India Circular No. 934/243, dated the 5th July 1921, to Local Governments on the subject of training probationers for the Indian Forest Service.

It may be useful to record a short history of the past training of officers of the Indian Forest Service. In the absence of interest in forestry generally in the Empire, it was natural that, at the outset, use should be made of forest schools on the continent and the British Officers who joined between the years 1869 and 1876 were trained either in France or Germany. Those who joined between 1877 and 1886 were trained in France, at Nancy. For the next nineteen years the Royal Indian Engineering College at Coopers Hill prepared the probationers and on its closure in 1906 the training was transferred to Oxford. In 1911, as a result of representations from other universities, the training was thrown open to the forestry schools at Oxford, Cambridge and Edinburgh and this system has been in force up to the present time.

It will be remembered that in a previous article we dealt with the discussion of the subject of Forestry Education at the Empire Forestry Conference, held in London in July 1920. This matter was further investigated by an inter-departmental Committee which arrived at the conclusion that the established forestry schools in England and Scotland must continue to fulfil their existing functions but that a Central Institution should be provided at Oxford for extension and refresher courses.

From the foregoing it will be gathered that training for the Indian Forest Service has been a matter of some difficulty and frequent changes have taken place. It is necessary therefore to look at this most important subject closely and impartially in order to prevent another false step, and it is to be hoped that the department, as a whole, and Local Governments will rise to the occasion and give this momentous question the closest attention.

The proposals of the Government of India are briefly as follows :—

(*a*) To continue to recruit the British element for the Imperial Service through the three principal schools at Cambridge, Oxford and Edinburgh, by the selection of probationers from those who have gained a diploma or degree in forestry.

(*b*) To adopt the recommendations of the Public Service Commission to establish, at Dehra Dun, a course of forestry equal in standard to the best British and European Schools and to train together Indian probationers for the Imperial and Provincial Services. At the end of the three-year course the best students would be selected for the Imperial Service, while the remainder would enter the Provincial Forest Service.

(*c*) To send the probationers selected for the I. F. S. under (*a*) and (*b*) above to the Central Institution at Oxford, to undergo a year's course of higher training in special subjects, including a study of continental methods.

In each case the vocational training would commence at school-leaving age so that recruits would join the service some two years earlier than they do now.

The British recruit would incur all the expense of his education up to the diploma stage but the cost of the training at Dehra would have to be borne by Government. It is estimated that, under this arrangement, the cost of an Indian recruit, exclusive of travelling expenses, would be about £1,500 and that of a British recruit £450. The relatively higher cost of the Indian recruit is said to be on account of establishing and maintaining, at Dehra, a vocational course of the standard required for, though Indian students will be expected to maintain themselves at Dehra Dun, it is not proposed to charge them fees for tuition. It is stated that this scheme, though expensive, is less so than that of concentrating all forest training of imperial recruits, both British and Indian at Dehra Dun, which is estimated at £2,000 per recruit.

The cost of training candidates for the Provincial Forest Service at Dehra is to be charged to Provincial Governments who will presumably be required to pay something in the neighbourhood of £1,000 for each recruit. The cost at Dehra of a Provincial and Imperial student will obviously be the same and a deduction of £500 may be allowed on account of passages both ways and of allowances, fees, etc., during the fourth year of training at the Central Institution at Oxford.

The scheme therefore provides for the support of existing forestry schools in Great Britain and for the organisation, in India, of the best training which the country can produce. All these institutions are to form the basis of elementary forestry education and of recruitment for the Imperial Service. The Central Institution is to put the final touches and polish on the probationers as a special preparation for their work in different parts of the Empire, but the latter institution is intended also to provide for specialisation at any stage of a forest officer's career. If the above proposals are accepted India will be equipped with a self-contained forest school which should meet all the aspirations of Indians to have as up-to-date a course in their own country as circumstances permit.

The Secretary of State for India is particularly desirous of ascertaining how the whole question is regarded by Indians, and Local Governments are asked to invite the opinion of Indians, both official and non-official.

We have dealt with this matter very briefly and refrained from criticism. The enclosures to the Circular occupy 45 pages of the Gazette and we invite the attention of all who are interested in this vital question to study the papers closely.

We consider the subject of such importance that we shall be glad to throw open the pages of this journal to its full discussion.

## AN EXPERIMENT WITH "ATLAS" PRESERVATIVE.

One gallon of Atlas "A" preservative was purchased from Messrs. Crowder and Co., Ltd., Bombay, at a cost of Rs. 12. Three plots totalling one acre and a half were treated with it in the beginning of June 1920 near Lachiwala as noted below:—

*Plot I.*—Area 4 square chains situated in young sal forest. The experiment was carried out with a view to killing worthless species interfering with sal. 261 trees, mostly *Mallotus philippinensis* with a few *Eugenia operculata* and *Randia* of different girths, were cut 1½ ft. from the ground and the substance applied to the top of the stumps with a brush. In addition to these, 8 trees of inferior species (one each of *Kydia calycina, Odina Wodier, Terminalia belerica, Terminalia Chebula, Grewia, Randia, Ehretia laevis* and *Mallotus philippinensis*) were girdled and the substance painted on the girdled surface of the stem.

Observations were made from time to time and those made in June 1921, *i.e.*, a year after the experiment was started, show that 200 trees out of 261 were killed outright; while those not actually killed were in a precarious condition and were not likely to survive. *Mallotus philippinensis* had not sent up any shoots and so far as this species, which is not easy to exterminate, is concerned, the result is very satisfactory.

Out of the 8 girdled trees, 7 have died, only *Odina Wodier* is still alive. This species will require a deeper cutting and thicker painting to ensure its being killed.

*Plot II.*—Area one acre. 207 *Bauhinia Vahlii* and *Millettia auriculata* climbers of fairly large dimensions were cut 1 to 2 ft. above the ground and the preservative was applied on the surface of the stumps. 120 climbers were killed outright and 50 were in a very precarious condition and will not send up any large shoots. The remaining 37 have not been affected.

*Plot III.*—15 large climbers of *Bauhinia Vahlii* and *Millettia auriculata* were treated. They were cut 1 ft. above the ground and the preservative applied to the *whole of the stump* above

ground and not only on the *top* of it, as in the case of Plot II. All the 15 climbers have been killed down to the roots.

The conclusions arrived at are :—

(*a*) It costs about Rs. 8 per acre to treat an area with this preservative for killing climbers and worthless species.

(*b*) The whole height of the stump above ground should be painted to be certain of killing it. Trees and climbers should not therefore be cut more than one foot from the ground, the lower the better, to reduce the cost of the preservative.

M. P. BHOLA, I.F.S.

## RESEARCH NOTES.

[These notes are published as an attempt to bridge the gap which exists between the Research Institute and the Department in general. It is intended to indicate at intervals as far as possible what work is going on but in the space at our disposal it is impossible to go into much detail. Further information is however always available from the officers who are conducting the investigations.]

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The Forest Economist attended a meeting of the Chief Engineers of Indian Railways and read a paper dealing chiefly with the results of the last ten years' experiments on the durability of treated sleepers. In the discussion which followed many questions were asked and the resolutions finally passed were as follows :—

(1) that treated sleepers were well worth consideration ;
(2) that it was advisable to erect treating plants at different centres for one or more railways ;
(3) that special care should be taken in seasoning before treatment and that treated sleepers should be laid heart up and sap down ;
(4) that the timbers to be used should be *Terminalia* spp. (except *belerica*), Dipterocarp spp., pines, spruce and other species indicated by the Forest Economist.

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The Officer-in-Charge of the Seasoning Section is engaged on a commercial scale experiment at Bareilly in connection with the seasoning of bobbins and cask woods, destined to be tested in England and S. India respectively.

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The Officer-in-Charge Timber Testing has carried out 206 tests on spruce redwood and whitewood sleepers to ascertain if both varieties are mechanically strong enough to be used as sleepers after treatment. Spike-pulling, static bending, impact bending, compression parallel to and perpendicular to the grain, hardness, shearing, and tension across the grain were tested,

The important tests in this case are spike-pulling and compression parallel to the grain. It is interesting to note that to extract the dog spike 3,390 lbs. were required in the case of the spruce redwood and 2,575 for spruce whitewood while chir requires 3,038 lbs. and deodar 3,612. The results are not yet complete but the redwood spruce has been found to be in every way superior to the whitewood for sleeper purposes.

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The Officer-in-Charge of the Paper and Pulp section has been consulted as to the feasibility of improving the methods now in vogue of making hand paper and pasteboards in India Jails.

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Certain Burma timbers are being tested to see if they can be used as sucker rods for oil wells. Hickory is used at present but it is anticipated that a Burma timber can be found to take its place. One firm alone imports hickory at present to the value of several lakhs of rupees.

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The Forest Zoologist is writing up information obtained regarding the insect pests of teak both borers and defoliators. He expects to have the manuscript ready for the Press in November.

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Specimens of the timber which has been seasoned naturally in different parts of India under the experiments of the Forest Economist have been received and the borers bred out in the Insectary. Some 8,500 specimens await identification.

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It has been found possible to grade boring insects into classes according to their ability to attack (1) the living tree, (2) the girdled tree, (3) the felled log, and (4) converted timber. The recognition of the first and last classes particularly permits a correct appreciation of the success or failure of the natural method of seasoning.

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The remedial measures being carried out with *Hoplocerambyx* in the Thano forest will, it is expected, result in effective control

of the pest. The result of last year's measures was to reduce the number of borer-infested trees much below that of any year since the detection of the epidemic in 1916.

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Over five hundred new species have been added to the collection since the Systematic Entomologist started operations.

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The Forest Botanist has been on tour in connection with his sal regeneration experiments and a great deal of his time is being taken up by the preparation of a new Botany Manual for the students. The branch is busy with identification work and distribution of seeds.

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A number of fixed oils and fats received from various Forest Officers are under investigation.

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The investigation of the oil from *Andropogon Jwarancusa*, Jones, has been completed. It contains approximately 80 per cent. piperitone which is possibly of considerable value and identical with ketone occurring in various Eucalypts especially *E. dives*.

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Consequent on the published results of the investigation into the leaf oil of *Skimmia laureola*, trade enquiries have been received from France, and the inquirers have been put in touch with the Indian producer.

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During the rainy season a considerable part of the time of the Research Officers is devoted to education. Each Officer gives a series of lectures in his own subject to the Provincial Service Classes so that the students are now equipped with up-to-date information on all subjects.

# EXTRACT.

## EMPIRE FORESTRY ASSOCIATION.

We reproduce below the following extracts from a pamphlet issued by the Governing Council of the Association :—

" *How the Empire Forestry Association Originated.*

In July 1920, the Imperial Forestry Conference held a session in London, which was attended by delegates from various parts of the British Empire. The result of their deliberations was to confirm the view that, speaking generally, the Empire is dissipating the enormous natural resources which it possesses in its forests, without making provision for their renewal ; while such vital matters as the yield and utilisation of timbers, the management of forests, forest education and scientific research are being neglected. The members of the Conference were also convinced that the administration of all our forest departments must be strengthened if the desirable policy of conserving and regenerating the forests of the Empire is to be effectively pursued.

A special Committee of the Conference appointed to outline a scheme for a British Forestry Bureau, drew pointed attention to the unsatisfactory position of forestry, and after explaining the scope and objects of such a Bureau, it concluded :—' We have not been able to ascertain precisely to what extent existing institutions in the United Kingdom and other parts of the Empire are attempting to deal with the problems of afforestation, but we do know definitely that these need to be tackled. The important matters with which the proposed Bureau would deal are at present in a chaotic state.'

Among the recommendations of the Imperial Forestry Conference are some which obviously fall within the province of Government. Institutions for scientific research work, or for the training of forest officials, can only be undertaken by the State, and should not be left to private or non-official enterprise. But in other directions, indicated in the resolutions of the Conference,

there is much to be done by voluntary agency, notably the work of publicity or propaganda.

Delegates to the Conference laid stress upon the need for a sustained effort to interest the community in forestry. This lies outside the purview of an official forestry department ; and they pointed out the disadvantage of propaganda work being carried out either by the State or by a purely commercial association interested, perhaps, financially in some particular forestry industry. In the former case the character or policy of Provincial or State Governments in the Dominions may debar Federal action, while, as regards the latter, information or exhortations emanating from an interested source would arouse suspicion.

On the other hand, there is direct evidence of the immense scope for voluntary forestry associations, which have no particular trade interests to foster, which are not officially subordinate to or leagued with, any Government, and are free to support or criticise, as the occasion may demand, the official forestry policy, or the lack of it, in the United Kingdom, Dominions or elsewhere. The great voluntary associations in Canada and Australia have greatly assisted in spreading knowledge as to the growth of trees silvicultural methods, and the production of timber, while in the U.S.A. they have intervened with effect in controversies connected with " conservation " and forest reserves.

*The Salient Features of the Empire Forestry Association.*

One result of the deliberations of the Imperial Forestry Conference was the foundation of a Central Association, named the Empire Forestry Association, for the following purposes :—

(*a*) To serve as a link between the associations already existing in the United Kingdom, Australia, Canada, and other parts of the Empire, and between individuals engaged in the work of the forestry ;

(*b*) To foster public interest in Forestry throughout the Empire ;

(*c*) To secure general recognition of the importance of forest management ;

(*d*) To collect and circulate information as to existing forest conditions, and as to the future timber requirements of the Empire ;

(*e*) To provide a clearing-house for information, and a centre for co-operation ;

(*f*) To organise meetings for the discussion of problems connected with the growth of timber and its utilisation.

The Empire Forestry Association, which is applying for incorporation by Royal Charter, is controlled by a Governing Council, the first members of which, representing the United Kingdom, Canada, New Zealand, Australia, South Africa, Newfoundland, India, and affiliated Associations and Societies, are nominated by name in the Charter and will hold office until the first General Meeting of the Association. Thereafter elections will take place annually to the Governing Council, which will comprise a Chairman, Vice-Chairman, and 45 members, of whom 9 will represent the United Kingdom, 10 will represent the Dominions, 2 will represent India, 6 will represent the Crown Colonies, and 18 will represent, in equal proportions, a ffiliated Societies in the United Kingdom and similar associations overseas.

For the better management of the affairs of the Association and the speedy despatch of its current business, the Governing Council will be empowered by the Charter to delegate all or any of its powers to an Executive Committee, chosen from among its own members, the Excutive Committee, as well as the Governing Council, being subject by the Charter to the control of the Members of the Association, assembled in General Meeting. All matters connected with the exercise and discharge of the powers and duties of the Governing Council, the business of the Executive Committee, and the rights and duties of Members of the Association which are not specifically provided for in the Charter, are to be dealt with in Bye-Laws which, before they can take effect, have to be in the words of the Charter, 'submitted to and allowed by the Lords of our Council.'

*How the Association is to be Financed.*

The Empire Forestry Association will depend for financial support upon the subscriptions or donations of its members, which are divided into two classes, namely, Individual and Affiliated members. In the former category come *Life Members* who subscribe not less than £20 before December 31st, 1921, and thereafter not less than £30; *Full Members*, who subscribe not less than £2; *Associate Members* subscribing annually not less than £1. Affiliated Members will include corporations, companies, firms, and associations who either subscribe before December 31st, 1921, a sum of £100 or contribute annually a percentage of the sum which they receive in the form of annual subscriptions from their own members, or who pay an agreed sum annually, to the Empire Forestry Association. The rights and privileges of these various classes of members are provided for in the Charter and Bye-Laws; while the Governing Council is empowered to prescribe the privileges of a special class of Honorary, Corresponding, and Foreign Members, whose election as members it may hereafter consider to be desirable in furtherance of the objects of the Association.

The Association will be empowered by the Charter to raise loans for carrying out statutory objects and purposes, particularly by the issue of Debentures, and to invest monies not immediately required in approved securities, subject to a general proviso that the income and property of the Association shall be applied only towards the promotion of its objects as more particularly prescribed in the Bye-Laws."

[The pamphlet is preliminary to the regular publication of a quarterly journal which will consist of about 100 pages of convenient size, and will comprise :—

(*a*) Original articles, partly scientific and partly of general interest;

(*b*) Reprinted articles from selected publications; and

(*c*) Editorial and correspondence columns.

Pending the completion of the arrangements for publishing the quarterly journal, occasional pamphlets of general interest will issue and that now under notice is the first of the series.

There can be no question of the value of an association founded with the objects above described but we doubt whether much support can be expected from India at the relatively high rates of subscription involved. It would, therefore, appear necessary to create, for India, a branch of the Empire Association subscription to which will be limited to little more than the cost of the quarterly journal, as the organisation would not have the wide field of activity or depth of penetration which it aims at unless the subscription is at a level which brings it within the means of all who are engaged and interested in forest matters in this country.

This matter is receiving attention and we hope to hear of definite proposals issuing at an early date.

Meanwhile all those who are interested can obtain the pamphlet and form of enrolment from us or from the Inspector-General of Forests.—HON. ED.]

## WORKING PLAN FOR THE RESERVED FORESTS OF THE PORAHAT DIVISION.

BY F. K. MAKINS, DEPUTY CONSERVATOR OF FORESTS.

The issue of this working plan will be welcome to all officers interested in sal. It introduces for the first time the conversion to uniform system to the Province of Bihar and Orissa and if the work prescribed is properly carried out considerable improvement in the growing stock should take place. The author's observations on the regeneration of sal are generally in agreement with those of Collier in Haldwani but Makins goes rather beyond Collier and states that—"A certain amount of shade appears absolutely necessary to establish the seedlings." On the other hand Hole has demonstrated that sal seedlings are best without any overhead shade at all but he rightly insists on the value of side shade. Success will, we think, lie in a judicious compromise between the two opposite considerations of light and shade.

The yield of the High Forest Working Circle is calculated in units of volume on a complete enumeration of P. B. I.; increment is not added for half the period. It is shown that there is a financial loss in retaining sal trees after they have reached 5 feet girth and the rotation is therefore fixed at 140 years divided into VII periodic blocks which are completely allotted. We are not in favour of such mathematical provisions, which are never adhered to in practice, and consider that the attempt to favour certain girth classes in each periodic block will do more harm than good, as has been experienced in Thano, where an exactly similar prescription has been in force for some years. Also we cannot agree that the subsidiary fellings in P. B. II should be improvement fellings pure and simple and very light at that. In our opinion they should consist of a final thinning or preparatory felling which amounts to the same thing. Thinnings are rightly insisted on in P. B. I and VII but are not prescribed in periods II—VI. This we consider a serious omission which should now be rectified. Our experience teaches us that thinnings are most necessary in the intermediate periods and that the quality of the

growing stock will be greatly improved by judicious thinnings Cleanings in the regeneration area are to be done annually as may be required and the burning of the ground leaf cover as a stimulus to regeneration is advocated.

The Coppice with Standards Working Circle is managed as follows: "the system proposed is, therefore, coppice with standards, the standards being separate groups of the original high forest and not individual trees standing over coppice."

It is a pity that this circle was not given another name as the silvicultural system is not coppice with standards at all. If good coppice regeneration is obtained the result will be uneven-aged high forest arranged in groups, and the future treatment in the second rotation will we think either tend towards uniform high forest or orthodox coppice with standards. No subsidiary fellings are prescribed and we have lately seen the bad effect of neglecting such work in other coppice areas. It is most necessary to thin out the coppice at regular intervals from the 5th year onwards and to keep the sal shoots free from competing inferior species. Climbers if at all numerous are the greatest nuisance in coppice and both the young shoots and the standards must be kept clean. We have little doubt that a few years' work will clearly show the necessity for such cleanings and thinnings.

The plan generally follows the lines on which other provinces are working and is a welcome addition to the list of up-to-date plans, introducing sound principles of silviculture and forest management. We congratulate the author on the result of his work.

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# INDIAN FORESTER

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## THE SWING OF THE PENDULUM.

### A DESCRIPTION OF DUCHAUFOUR'S METHOD.

The recent article in the *Indian Forester* demanding, what the author was pleased to call, a "Forest Soviet" finds its echo in the opinions of many members of the great continental forest services. These opinions are not merely the bubble bursts rising from the boiling pot of heated criticism through which test all thoughts and ideas, however long they may have been upheld, are now passing. They are the result of long-considered cogitation, which has been brought to a head by the frenzied post-war conditions. It would have been surprising if such a stabilised idea as the system of "*successive regeneration fellings and thinnings*" in France had escaped this cauldron. Its widespread use and the fact that it seemed to be accepted as without blemish alone marked it out for special censure. The criticisms levelled at its head may be put under two headings: those dealing with the restrictions its application attempted to impose on the forest

itself, and the others concerning the manner in which it tied the hands of the forest officers themselves. The former is largely a matter of forest management and the latter of silviculture. These correspond practically to the French distinction between the "*réglement général d'exploitation*" and the "*réglement spécial d'exploitation*," and it is naturally more logical to discuss the wider aspect first.

The system of "*successive regeneration fellings and thinnings*" and "*periods and periodic blocks*" was introduced into France in 1820. The French accepted Cotta's idea of basing the working plan on periodic blocks fixed by area[1], but they still imagined, with Hartig, that these periodic blocks could be laid down definitely for the whole rotation. They even went further and insisted on the periodic blocks being self-contained. These fixed and self-contained periodic blocks, besides demanding considerable sacrifice in the way of regenerating immature woods and leaving older and mature crops to deteriorate, made the working plans so rigid and so difficult to follow that the necessity for the introduction of some modification soon became apparent. The first real step in that direction is to be found in a note issued by the Inspector-General of Forests, to the effect that, should the regeneration of a compartment in the periodic block under regeneration demand any considerable sacrifice, it was to be exchanged temporarily with an older compartment, ready for felling, in a periodic block not under regeneration at the time. This gave rise to the system which is now becoming more commonly employed in France, namely that, owing to this right to exchange compartments temporarily from one periodic block to another, the periodic blocks are no longer permanently fixed, nor necessarily self-contained, and may be altered at the end of each period. The old maps, nevertheless, are often still maintained showing beautifully-coloured, fixed, self-contained periodic blocks. Some foresters, however, were not satisfied with this. They said—and it would appear with some justice: "If the periodic blocks may be altered at each revision

[1] Thus Cotta writes: "The area is the true foundation and the most certain basis on which to calculate the possibility of forests and to appreciate their state."

and the Forester does not know, with any degree of certainty, the future sequence of the regeneration fellings, would it not be sufficient merely to fix the first periodic block or area under regeneration—and perhaps the second periodic block tentatively—and to lump the remainder of the forest together as "*the rest*"? This looks very revolutionary on paper—and particularly so to a keen follower of that deathless quarry "the normal forest"—but as will be seen in the two examples of this modification given below, a knowledge of the distribution of age-classes and the character of the crops over the whole forest is still required.

The much misunderstood "*Quartier-Bleu*" system was the original and implied nothing more or less than that all the areas partially regenerated and all the areas ready for regeneration were placed in Periodic Block Number I. An equivalent number of years for their regeneration was calculated according to the relation their total area bore to that of the whole forest. This system, however, needed modification because the areas comprised in Periodic Block I under the clauses given above might be any size, but were, in actuality, too large. One-third or even one-half of the crop could, in some cases, be placed in the regeneration block giving periods of 50, or even 75, years during which this area was to be regenerated. No forest officer, whatever his opinions might be, could possibly demand a periodic block which is going to take himself, his son and his grandson to regenerate. Matters were further complicated under this régime by the fact that at each revision, commonly every 10 years, any area fully regenerated was cast out of the period, and any areas in "*the rest*" of the forest, which since the last revision through any cause whatsoever, had reached a state of demanding regeneration, were included in the area under regeneration. This meant that the size of the area under regeneration and automatically the corresponding period were continually altering, thus introducing unnecessary complications.

It was then that Mr. Duchaufour stepped on the scene with his system which like all ideas which wish to ensure permanence is a compromise · in this case a compromise between the rigid, fixed,

self-contained blocks on the one hand, and the loose ideas gathered together under the title "*Quartier-Bleu*" on the other. The main objects of the Duchaufour system are to maintain a proper control over the management of the forest while giving the forest officer not only a larger area in which to carry out the regeneration fellings, but also a much freer hand in the selection of the areas to be regenerated. The first object is achieved by having a definite limit as to the size of the area of forest which is to be under regeneration at any one time; this prevents the absurdities liable to occur under the original "*Quartier-Bleu*" system. It matters little whether any attempt is made to lay down the other periodic blocks definitely, as they will always be subject to constant revision. This would entail the employment of a draughtsman for a few hours as all the necessary data must be obtained, in any case, in order to choose the periodic block under regeneration.

The second and third objects are attained by allowing the forest officer to choose the regeneration area from anywhere in the forest according to the cultural demands of the crop and by legislating for the intervals between revisions of the working plan to be shorter than the period. At these revisions areas fully regenerated are cast out and an equivalent area demanding, or ready for, regeneration is taken in from the "rest" of the forest. The result is that, if, for example, the rotation is 160, the regeneration period 40, and the revision period 20 years, the forest officer, instead of having one-quarter of the area in which to make regeneration fellings for the whole 40 years, has one-quarter for the first 20 years and still one-quarter for the second 20 years.

Perhaps a clearer idea of the system may be gained from the citation of an actual example. The forest of Eawy is situated in Seine Inferieure a few miles south of Dieppe. This forest comprises 6,700 hectares divided into 9 felling series of approximately equal area. Each series is divided into 20 or 30 regularly-shaped compartments, and each compartment has as far as possible a homogeneous stocking. The forest is under beech high forest with a rotation of 150 years worked under the system of successive regeneration fellings and thinnings. In the words of the officer

in charge: "The system of permanent periodic blocks has been abandoned in favour of that of Duchaufour and instead of the compartments under regeneration being contiguous they are, if necessary, spread about the series, according to the requirements of the crops." The W. P. period in this forest is 22 years and the revision period 10 years, but the lengths of these periods have little direct bearing on the question of this particular system as, in the working plan now awaiting sanction for the neighbouring Forest d'Eu, working plan and revision periods of 40 and 20 years respectively have been chosen. For purposes of management the crops are allotted to two big classes. Class I, the area under regeneration fellings, is, in both these forests, Eawy and Eu, about one-quarter of the whole felling series. Class II includes all the remainder of the forest which is under thinnings by area. The classification will be better understood by a survey of the statement below :—

| | | | *Nature of Operation.* |
|---|---|---|---|
| Class I. Exploitable crops providing the principal fellings. | Group I. | Crops partially regenerated. | Intermediate and final fellings by volume. |
| | Group II. | Crops under regeneration. | Seeding preparatory and intermediate fellings by volume. |
| *Class II.* Immature crops to be maintained under improvement fellings. | *Group III.* | *Woods 100—120 yrs.* old. | Thinnings and cleanings by area. |
| | Group IV. | Woods 50—100 yrs. old. | |
| | Group V. | Woods 0—50 yrs. old. | |

It may be mentioned here that the thinnings are carried out under a 10-year cycle and the object of having 20 or 30 compartments in each series is that in any particular year those compartments are chosen for thinnings whose ultimate numeral is the same as that of the year, thus in 1922, compartments 2, 12 and 22 would be thinned, except in Group I and II. This method is very rigid, but it has been found to answer admirably in the pure beech woods of northern France.

It might be put forward at first sight that Class I could not include one-quarter of the whole area, but it must be remembered that Group V by no means includes all the young crop. A considerable portion of the very young, newly-regenerated woods will

be included in Group I as patches of regeneration among the remaining seed trees. It is this complication which has given rise to the necessity of ascertaining the possibility by a method peculiar to this system as *the reduced area of Group I* must be found, that is, the area equivalent to the remaining seed trees. The reduced area of Group I plus the area of Group II will bear the same relation to the whole area of the series, as the number of years during which the volume of the trees in Groups I and II will be felled, will bear to the whole rotation.

The first step is the enumeration of all trees in Groups I and II and the calculation of the volume by means of local volume tables. The volume possibility is then found by the formula

$$P = \frac{V \times S}{C \times R}$$

where V = Total volume of Groups I and II plus 2 per cent. for increment.

S = Total wooded area of the series.

C = Real area of the compartments of Group II together with the reduced area of the compartments of Group I.

R = Rotation, *e.g.*, 150 years.

The only unknown quantity here is C, the combined area of Groups I and II and the ascertainment of its value is based on the theory that in regular high forest each stem can develop normally, only when it occupies a space proportional to the square of the diameter of the trunk. This space can be measured as a square constructed on a side equal to K times the diameter. K is the co-efficient of density. The area of a compartment of even-aged high forest containing 'n' trees of a mean diameter 'D' is $(KD)^2n = K^2D^2n$. From numerous measurements of fully-stocked crops of Group II it has been found that K has an average value of 16 and this holds true for all the series. Therefore $C = 16^2D^2.n$.

This has been verified in several fully-stocked crops in the forest and the actual area has been found to be equal to the theoretical area calculated with this co-efficient. As an example

compartment 21 in the I felling series has an actual area of 25 hectares.

Number of trees = 5,253.

Volume of these trees = 7,165 cubic metres.

Average vol. per tree = 1·364 cubic metres.

Volume tables show that the nearest diameter corresponding to this volume is 0·45 metres, which gives a volume of 1·500 cubic metres. The required average diameter is therefore given by

$\frac{D^2}{d^2} = \frac{1·364}{1·500}$ where d = 0·45

where $D^2$ = 0·184.

The reduced area of the compartment is therefore

$= K^2 . D^2 . n.$

$= 16^2 \times 0·184 \times 5,253.$

= 24·74 hectares.

This is very nearly equal to 25 hectares, the real area.

The necessary substitution for C gives

Possibility = $\frac{V \times S}{R \times K^2 D^2 n}$ where K is 16.

The application of this method and formula offers no more difficulty in the regular beech forests of North France than does the more usual form applied to the uniform system with its full quota of equal periods and periodic blocks. Moreover, here, as in other systems, it may be found during the selection of compartments to place in the regeneration period that the age-classes are abnormal. The possibility is then increased or lessened according to circumstances in order to keep the yield sustained, *i.e.*, to allow the backward age-classes to catch up or to prevent the accumulation of mature timber in the forest. Minor alterations are unnecessary as most French forests are divided into felling series and it has been found in actual practice that the annual timber output of the whole forest remains more or less constant in normal times. It is obvious that this prolonging or shortening of the period during which the trees forming the volume " V " are to be felled may, and indeed is almost sure to, interfere with the cultural demands.

As the crux of the Duchaufour system is that, in some way, it meets the demands of the modern trained forest officer for more

scope in his work it is not without interest to review shortly the recent paper by Emile Mer in the Bulletin Trimestriel, March 1921, of the "Société Forestière de Franche Comté et Belfort." His views are even more extreme than those of most of his contemporaries, and, in writing of the silver-fir and spruce selection forests of the Vosges, he demands the abandonment of the sustained yield, the possibility by volume and the counting of all "chablies," windfalls, dead trees, etc., against the possibility. His contention is that all these controls interfere with the necessary silvicultural operations and that they tie the hands of the man-on-the-spot who should be in the best position to decide what is the right thing to do. The equal annual sustained yield he banishes with the arguments that it is of interest only to owners of small woods and to small communes; the latter because they provide the inhabitants with the actual produce direct. The State, he claims, has no call to demand an equal annual sustained yield; firstly, because, however accurately balanced the annual produce outturns may be, the annual money yield will always vary; secondly because, as stated above, one felling series will balance another and one forest another; thirdly, because the total profit from all the State forests is negligible when compared with the enormous amounts that have to be budgeted nowadays, and that the entire absence of any returns from the forests would have little affect on the Treasury estimates. The volume possibility, M. Mer says, should, if retained at all, merely be kept as a check to prevent any very gross errors on the part of the forest officer. He discounts any chance of this with pleasing confidence. His contention with regard to the "précomptage" has certainly much to be said for it. The "précomptage" is the process of counting the volume of any windfalls, or trees felled or dying through any other causes, against the possibility. Under the present régime if there is a big clearance of this nature, all other operations, however urgent, cease until the volume of the "précomptage" has been worked off against the annual possibility. What M. Mer would like to see would be a selection forest worked under a rotation of (say) 100 years

divided into a 10-year felling cycle. Every year the forest officer would go into one-tenth of the forest and carry out all the necessary silvicultural operations, cleanings, "liberation" fellings, thinnings, secondary and final fellings; any or all of these operations might comprise the removal of one tree only in any one part of the one-tenth under treatment.

These demands are rather staggering, but they are interesting as showing what is perhaps the extreme case in the forest officers' cry for more freedom. They represent the swing of the pendulum away from the rigid working plan where even the actual dates of the various regeneration fellings were sometimes laid down. They bring those forest officers who are responsible for the manufacture and maintenance of working plans in the various forest services face to face with the question: "How much ought we to lay down definitely in working plans? What restrictions, if any, shall we impose on the man who will have to *carry* out the prescriptions of this plan? Cannot we make suggestions, culled from past experience, and leave him to apply or discard them as his judgment dictates?"

*Resumé.*—The Duchaufour system is a tangible expression of the demands of the executive forest officer for more scope to exercise his art. The regeneration periodic block alone is fixed definitely and then only for the revision period. This regeneration periodic block is normally maintained at about one-quarter of the whole area, and those compartments which have been completely regenerated are thrown out at each revision and other compartments of about equal area taken in. This means that the forest officer has all the time almost one-quarter of the area in which to make regeneration fellings. In the ordinary fixed self-contained periodic block system as applied in a forest worked under a rotation of 150 years and 5 periods, he has, at the most, 1/5 of the area and this dwindles until it is nothing at the end of each period. The method of calculating the possibility demands knowledge of the relationship that exists between the reduced area of Group I, plus the real area of Group II, and the total area of the felling series. This may appear very

complicated but the formula used for arriving at the reduced area of Group I is of very simple application as the constant 'K' can easily be found from the results of numerous previous enumerations.

*Conclusions.*—The one great advantage of the Duchaufour system is that it gives the forest officer a larger area in which to carry out cultural operations other than thinnings and yet this area is limited. A further control can be exercised by inserting the clause, found in nearly all French working plans of forests managed under the method of successive regeneration fellings, that no new seeding fellings are to be started until all necessary final fellings have been carried out. Other minor, but nevertheless considerable, advantages of the system are that having only one periodic block definitely fixed, and then only for the revision period—it avoids the mathematical rigidity of the fixed self-contained periodic blocks and at the same time does not demand the sacrifices involved in obtaining and maintaining these self-same fixed self-contained periodic blocks. It permits also the prompt replacement of regenerated areas; fresh areas are placed in the regeneration period for silvicultural or economical reasons or because badly damaged by insects, fungi, storms, etc.

The main objection raised by the forest officer in charge of the forest d'Eu was that the compartments under regeneration being scattered, the forest guards found it more difficult to exercise proper supervision over the felling areas. This is, however, rather a psychological objection due to the fact that the whole of the French Forest Service has been brought and bred up on fixed, self-contained periodic blocks. The slightly greater complication entailed nowhere near outbalances the advantages and the most serious objection that could be brought forward would be that the comparatively large area under regeneration—one-quarter of the area for a forest under a rotation of 150 years—would demand more work in enumeration. This objection has been met at Eu, by raising the revision period to 20 years which is ample under this more elastic system.

C. R. ROBBINS.

## THINNINGS

Whether as the result of artificial or of natural regeneration a time arises sooner or later when thinnings become necessary in every forest crop. In the case of conifers this operation may be *delayed for a considerable number of years, whereas in the* case of teak thinnings may be necessary when the crop is one or two years old. As we have already seen in the case of natural regeneration every species will require different treatment and the forester carrying out this operation must have a clear understanding of the habits and growth of the trees with which he is dealing.

A thinning consists in lessening the crowded condition of the best trees in a canopy so as to favour their development. In the case of most conifers it is essential that thinnings should commence early so that good healthy stems with crowns of sufficient vigour to withstand snow should be produced.

"*The first thinnings must be executed without thought of* the value of the produce extracted, the sole object being the future of the crop." In dense coniferous reproduction or in line sowings this work may commence with the pruning knife when the plants are about two or three feet high. Later when the crop is six feet or more in height and has covered the ground with a complete canopy the first thinning may be carried out. This is equally important in the case of conifers and sal and a neglect of this necessary work has resulted in the deformation of extensive areas of sapling crops. The most practical way of doing this work is with an intelligent forest guard who is given a stick of a certain length with the order that this stick has to pass between *all the trees left standing. Where the stick will* not pass between two trees the best one is kept and the worst marked for felling. The guard marks the trees to be removed and a gang of coolies working with him cuts them down. The stick may be of any length ordered but for sapling crops under 6″ diameter, to which crops alone this method is intended to apply, a 4 foot stick is

recommended for conifers and a 3 foot stick for sal. The final spacing of the trees left standing will be about $1\frac{1}{2}$ times the length of the stick used. Extensive areas of various species have been thinned in this way in many divisions of Northern India and the method can be recommended with absolute confidence.

It has been stated that thinnings are undesirable or unnecessary in the case of sal; a mass of figures go to show however that thinnings in sal are absolutely necessary if a reasonable rotation and increment is to be maintained. Two plots in Haldwani have been under observation for 28 years. One was never thinned and the other was thinned once in 1884 and never again. The increment for the first 50 trees in each plot (stretching from 18″ to 60″ girth) shows—

For unthinned plot = 7·5″ per tree.

For thinned plot = 13·7″ per tree.

Assuming this rate of increment spread over the rotation (and the large difference in limits of girth in each plot makes this justifiable) it shows that in 120 years—

An unthinned crop would attain 2′ 8″ girth.
A thinned " " " 4′ 10″ "

How much more the latter increment would have been accelerated by subsequent regular thinnings is proved by the slowing down of the increment curve of this plot while neighbouring regularly thinned plots show accelerated increment for every thinning. Exactly similar results are shown by the two Chaukhamb sample plots in Lansdowne, situated side by side and measured annually since 1902. The thinned plot only had one thinning in that year and the immediate stimulus to increment is at once apparent from the graph attached—Plate 13. The old Dehra Dun sample plots which extend over a period of 24 years with one thinning only show a rapid increment for the first five years after the thinning, after which the effect of the thinning began to wear away and the increment became very slow towards the end. Averaging the measurements of hundreds of trees in five different localities and calculating the rotation on the periodical increment

THE EFFECT OF THINNINGS IN SAL

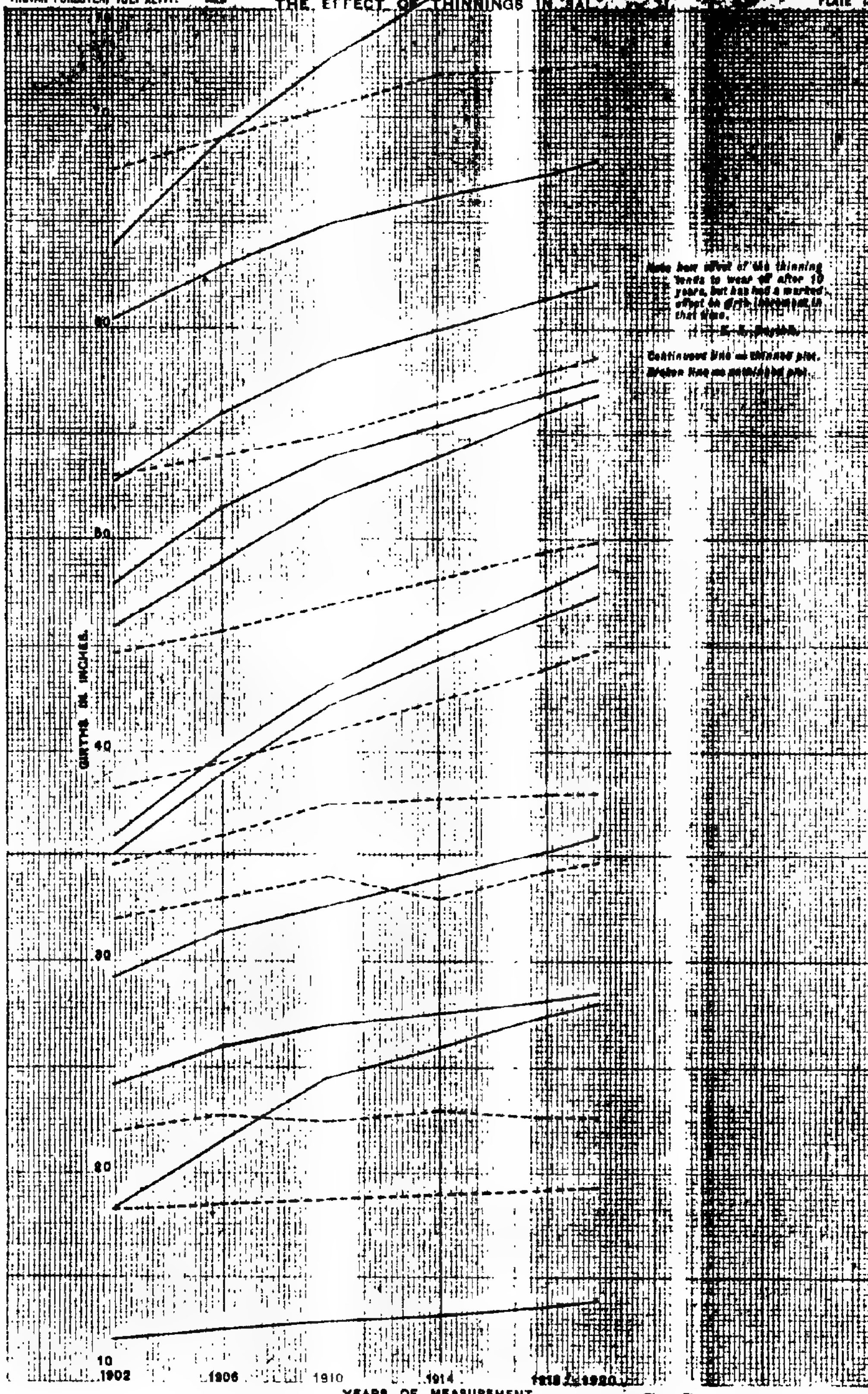
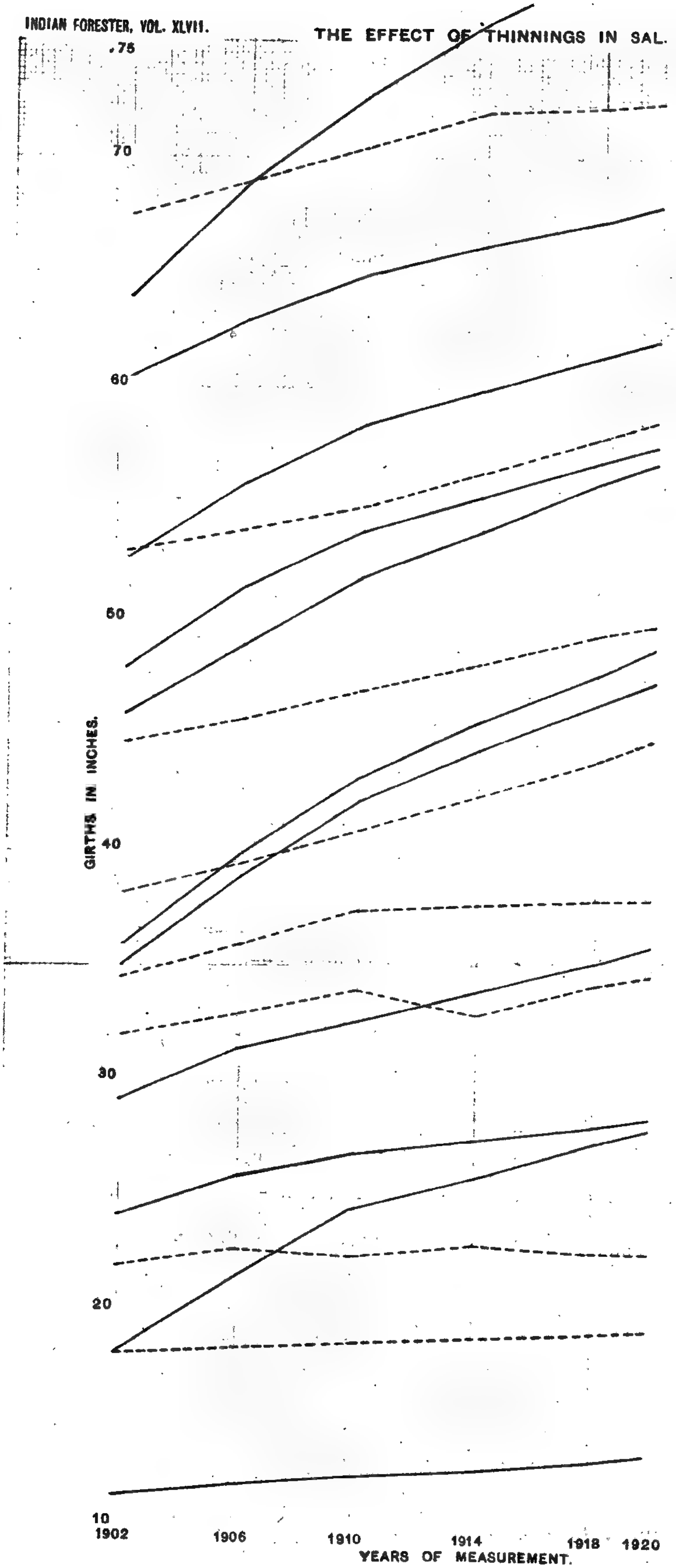



Photo. Zinco. August, 1920.




*Note how effect of the thinning tends to wear off after 10 years, but has had a marked effect on girth increment in that time.*

*E. A. Smythies.*

*Continuous line = thinned plot.*
*Broken line = unthinned plot.*

Photo. Zinco. August, 1920.—No. 3386-856.

on the 5, 10 and 24 years subsequent to the first thinning, rotation for a 5 ft. girth sal works out as follows :—

| | | |
|---|---|---|
| On the 5 year period | | 89 years. |
| 10 " | " | 117 " |
| 24 " | " | 154 " |

A comparison of the condition and appearance of the thinned sample plots with the unthinned forest around them is sufficient to convince any forester of the necessity of thinning this species. Thinnings are universally admitted to be necessary in European forestry, they are essential to the Himalayan conifers and absolutely necessary in the case of teak and sissu. It is therefore unreasonable to suppose that sal is alone in not requiring thinnings and the figures given above clearly prove that this tree follows the same fundamental rules as other species.

The opinion has been expressed that a growth of epicormic branches on sal indicated an excess of light but this is entirely a wrong assumption. The formation of epicormic branches both in the sal and the European oak is an indication of ill health and is generally due to the crown of the tree being unable to obtain sufficient light to support normal growth, resulting in all the dormant buds on the stem being called upon to put forth leaves to assist the crown in supplying sufficient nourishment to the stem and roots. Epicormic branches are also produced after a fire by injured trees for similar reasons, namely to increase assimilation with a view to repairing the damage done by fire. Healthy sal trees with normal crowns do not produce epicormic branches even when growing as standards in a coppice and the properly thinned sample plots are singularly free from this defect.

Thinnings permit of the realisation of the legitimate intermediate yields, they shorten the rotation and improve the quality of the final crop. They are essential under all silvicultural systems and their neglect in working deodar under selection in Jubbal has been most unfortunate. Innumerable instances can be given where thinnings in sal and oak worked under selection are the crying silvicultural need of existing crops.

The degree of the thinning will vary with the species being dealt with. It is impossible definitely to describe what constitutes a correct thinning, but the experienced silviculturist will know exactly what degree of density is desirable in each and every case and will act accordingly. The golden rule is to begin early, thin moderately and repeat as often as necessary. The art of thinning can only be acquired by experience, observation and thought, but there are now fortunately plenty of trained foresters, who are quite competent to do this work under the direction of a Divisional Officer, who knows and can explain exactly what he wants. McIntire in speaking of deodar has stated: "I have come to the conclusion that in thinnings one should be guided entirely by the condition of the canopy formed by the dominating stems. The removal of the suppressed poles occupying little or none of the space in the canopy appeared to me to be quite a minor consideration." Again Broillard writes: "Pine woods require early thinning, failing this the trees languish." Where snow break or strong winds are to be feared, the sole method of preventing loss is by thinnings which prepare the trees for an isolated condition and strengthen their stems and root systems.

Thinnings promote not only diameter but height increment, Chavegrin is positive on this point: "It is believed that trees grown under crowded conditions are more rapidly drawn up and attain greater length of bole. The error of this assumption has been long since revealed by research. In truth trees of the same age growing in a dense crop are far behind those standing in rational freedom, the greater the number of stems per unit of area, the more patent is their inferiority in height." Again Gazin states: "In trees suitably spaced the height increment is proportionate to the diameter, which latter is subserved by subsequent thinnings." Experiments carried out by the forest branch of Munich University went to prove that "when thinnings were carried out freely, the development in height was relatively much greater than the diametrical increment and at any rate during a certain period in the growth of crops, the heaviest degree of

thinning produced the loftiest and cleanest boles." The whole science of thinning is crystallised in the works of the International Congress of Silviculture in 1900. "All struggle between neighbouring stems must be avoided, for it is always at the expense of growth that it takes place. The formation of the stems of the prospective crop, in as large numbers as possible, must be assisted by gradual freeing beginning at an early age. When they are formed they must be successively thinned out to enable them to develop their crowns and root systems."

It must not, however, be presumed from what has been written above that heavy thinnings are necessarily advocated. The method of thinning different species will vary considerably; the pines live in a canopy, open but evenly distributed, quite a different style from isolated trees. The deodar grows in a moderately dense wood, but the individual crowns must be given sufficient room for their proper development, if too crowded they become attenuated, the trees develop a sickly appearance, and increment practically ceases. The silver fir loves tranquillity, it amplifies its foliage slowly and never much; it likes coolness and freshness and suffers from the introduction of sun and wind, it loves a close canopy and this must at all costs be maintained. In the case of spruce it should be remembered that the production of clean stems is essential if the highest price is to be obtained for the produce. The Indian spruce has longer fibres than any other spruce in the world, and there is a great future for clean slowly grown stems of this species. The wood should therefore be kept close and even, and thinnings carried out in a careful and regular manner, gradually reducing the number of the dominating stems by freeing the best and most vigorous crowns among them, but remembering always that the crop is one united whole, inter-dependent and inter-responsible.

Bagneris asserts: "To obtain the full benefit of thinnings they must be repeated whenever the crop becomes too crowded to allow of the normal expansion of the crowns; observation shows that they should be more frequent during the period of height growth, and that they should preferably occur after equal intervals,

in general every 10 years up to the 70th year or less according to species."

It cannot be too often asserted that thinnings must be made in the canopy of the dominant trees. Suppressed trees may be removed by all means if there is any demand for them, but their removal has no effect on the silvicultural condition of the main crop. In some cases in dealing with the sal it may be desirable to retain the suppressed trees to conserve the moisture content of the soil to the maximum. Howard has made an attempt to classify thinnings *vide* proceedings of the Indian Silvicultural Conference, 1918. His grade A and B of ordinary thinning *éclaircie par le bas* are of no value whatever as a silvicultural operation. His grade C is too drastic in that it involves the removal of all classes of trees save the dominant and the thinning of the latter. This prescription is certainly modified by his two qualifications :—

(*a*) In all cases in which holes would be created by the removal of dominant trees, dominated and suppressed trees should be left to cover the ground.

(*b*) In removing sound dominated trees with badly shaped crowns or boles, the operations must be made with due regard to the stocking and condition of the whole crop.

It would have been better to incorporate these essential provisos into the main rules and not lay down that all trees other than the dominant trees should be removed. Again in his definition of crown thinning it is prescribed that dead trees and part of the dominant trees will be removed but that the dominated and suppressed trees will be left to shelter the soil. It is contended that a correct thinning by which is intended a compromise between '*eclaircie par le haut*' and ordinary grade C thinning will involve—

(1) the regularising of the canopy by thinnings among the best dominant trees;

(2) the removal of badly shaped dominant trees in favour of well grown dominated trees;

(3) the thinning out of the dominated trees in favour of the dominant trees or alternatively for the benefit of other dominated trees retained as part of the crop.

The removal of suppressed trees is a matter of expediency depending largely on local markets for the produce. Wherever possible they may be cut, and in coniferous forest their retention is undesirable but, as already noted, under certain circumstances in the case of sal they are better kept, to shelter the ground.

Trees top-broken by snow have a great power of recovery and should not be removed merely because they have lost their leader. Unless broken in half or otherwise irretrievably damaged they should only be removed under the ordinary rules for thinnings.

The question of the correct manner of executing thinnings has been studied for many years, and after carrying out this operation over many thousand acres and seeing the deplorable results of a neglect of this most important work, the writer is in entire agreement with the words of the eminent authorities already quoted: opinions which may be aptly summed up in the words of Cannon:—

"The health, the life of the crop lies in judicious reiterated thinnings."

"TROWSCOED."

## KHEDDAHS IN CHITTAGONG DISTRICT.

BY M. A. T. MARCHANT, P.F.S.

Kheddahs were first conducted in this part of India by Sanderson in 1876, and for an account of his operations the reader is referred to his book, " Thirteen Years Among the Wild Beasts of India."

On the closing down of the Kheddah Department the trained employees were scattered far and wide ; the local men trained by him forming into gangs under various jamadars took service in various parts of India and Burma and one of these, Ossi Meah, Jamadar, was the first man to reopen kheddahs in these parts, and thanks to him and other jamadars I have met, I have learnt what I have about elephant catching.

Kheddahs were conducted under license by private individuals between 1913 and 1919, the most successful being Ossi Meah's in the Patiya Forest in which 43 elephants were caught, and another by his son Suraj Meah at Chunattl where 37 were caught.

According to local tradition there are three ways of catching elephants :—

*Bangri shikar*, building a stockade in a likely situation and then going off to find the elephants and drive them to the stockade.

*Mela shikar*, finding a herd of elephants, surrounding it and then rapidly building a stockade close by into which the elephants are driven.

*Phansi shikar*, in which no stockade is used. Tame elephants (*kunkis*) are taken up to the wild herds in the forest and wild elephants caught by throwing heavy rope nooses over their heads. In some parts of India this is called *mela shikar*.

The captures made by Ossi Meah and Suraj Meah referred to above were both by *bangri shikar*.

The following description of *bangri shikar* is given from the writer's own experience.

The kheddah season continues from November to March. It is essential that sites for stockades, or *bangris*, as they are locally known, should be selected before the staff arrive at the kheddah camp, to obviate a waste of time. Hence in October a small gang of trained elephant men, known as *panjalis* roam over the area which is to be worked, marking down the herds, obtaining a general knowledge of the country with the assistance of local guides, and, after thoroughly satisfying themselves of the suitability of the ground, fix the sties on which the *bangris* or stockades will be built.

The site elected is generally on what is known as a *Raj Mallum*, *i.e.*, where at least three elephant paths (*dandies* or *mallums*) meet.

The site being selected, information is sent to the kheddah party who on arrival pitch camp not less than a mile from the

site selected for the stockade, and in such a place as not to interfere with driving operations.

The business of building the stockade then commences.

Before the jungle is cut, or a single post put into the ground, a *sinni* is made, *i.e.*, a sacrifice offered consisting of the preparation in a huge vessel of a mess of rice, ghee, spices, etc., which is prepared with great pomp and ceremony, prayers being said by the kheddah *moulvi* while the sacrifice is being prepared. When cooked it is a sweet, sticky, fluid mess. Portions of this are distributed to the entire staff, and other portions put out in the jungle as propitiatory offerings to the jungle gods.

After this the area which will be covered by the stockade is marked out by a cleared circle or elliptical figure, at least 50 feet wide. The larger this circle the greater the convenience for stacking the poles, posts, and struts used in the construction of the stockade.

The exact situation of the two gate posts is next fixed. A gate facing south is unlucky, and one facing east most desirable. The kheddah people are very superstitious and their superstitions have to be respected if any measure of success is hoped for.

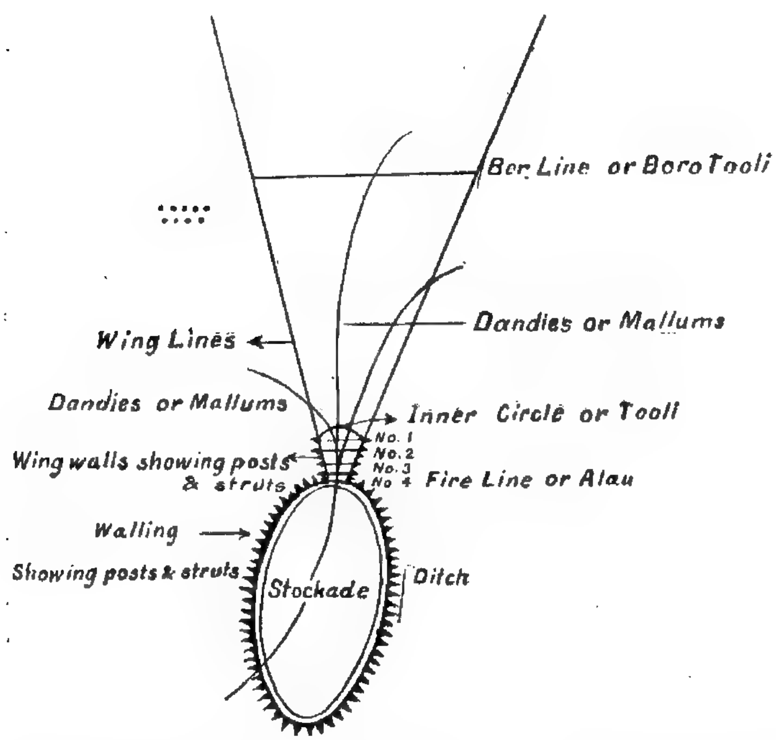
When the exact position of the gate posts has been fixed the area covered by the stockade is marked off in sections and apportioned to each *manjhi*, a *manjhi* generally being in charge of 20 men. The *manjhis* are responsible for the construction of the stockade wall and should any particular section give way when the elephants are captured, the *manjhi* is so tied up by agreements with the kheddah jamadar or superintendent, and the terms of the agreement are so harsh, that he is sold up, lock, stock, and barrel, to meet the amount of the fine that he is bound by agreement to pay. This has been found to be essential if good results are to be obtained.

While the stockade is being built the gate *manjhi* sets about building the gate. (The stockade building does not interfere with this as a small section is left on each side of the gate posts known as the '*adania pat*').

In the old days the selection of the stockade site meant selecting a place in which at least one living tree was available for one of the gate posts. This idea has since been abandoned, fortunately for the peace of mind of the kheddah superintendent.

The two gate posts have to be at least 40 feet high with V ends on which the beam rests which carries the gate. Only heart-wood can be used as the posts have to bear the charges of the elephants. The selection of these often gives a lot of trouble, and unless trained elephants are to hand, getting the posts to the stockade is a wearisome business.

When cleaned of sapwood the gate posts must hav a girth of at least 4 feet 6 inches at breast height. To my personal knowledge




more than one accident has resulted from carelessness in selecting the gate posts.

Preparation for the stockade.

Raising the gateposts.

The gate itself is made of a frame-work of hard wood poles, lashed and nailed together.

When the gate is ready, the section left as mentioned before is connected up with the gate post, and the walling already built putting the finishing touches to the stockade, after which a ditch is cut right round the inside of the stockade (except in front of the gate) just sufficiently clear of the walling not to impair its strength. This protects the walling from the charges of any of the catch when made.

When the stockade is nearing completion, a small party is sent out to get in touch with the wild elephants, and remain out sending information to camp till the driving party join them.

When the stockade is completed, the wing walls, fire-lines and wing lines are built as shown in the sketch.

The length of the wing walls and other appurtenances of a complete stockade depends entirely upon the configuration of the ground. The thing to be remembered is that the splay of the wing walls should not be too great, else the elephants will play up between the wing walls, after crossing the fire-lines. When the wing walls have been built the fire-lines are taken in hand. These consist of narrow lines the spacing between which depends upon the configuration of the ground. Along them stacks of firewood are placed at every eight to ten feet, and covered over with grass. Dry leaves and other inflammable materials are placed in the centre and kerosene oil sprinkled over those, to enable them to catch fire at once when touched with a lighted torch. There are four of these lines, Number I being closest to the gate, Number IV being known as the *tooli*.

While this is being done, the cutting and clearing of the wing lines are taken in hand. Along the wing line will generally be found various elephant paths or *mallums*, which points have to be specially guarded by reliable shikaries or else the elephants may break through and get clean away. The breadth of the wing lines should be at least 40 to 50 feet as elephants baulk at cleared spaces; besides, when the elephants charge the line they can be spotted before they are on the top of the men holding it, and steps can be taken to prevent their breaking through.

After the wing lines have been cut, the *ber* line is cut. This is a cleared line 8 to 10 feet wide, joining the ends of the wing lines.

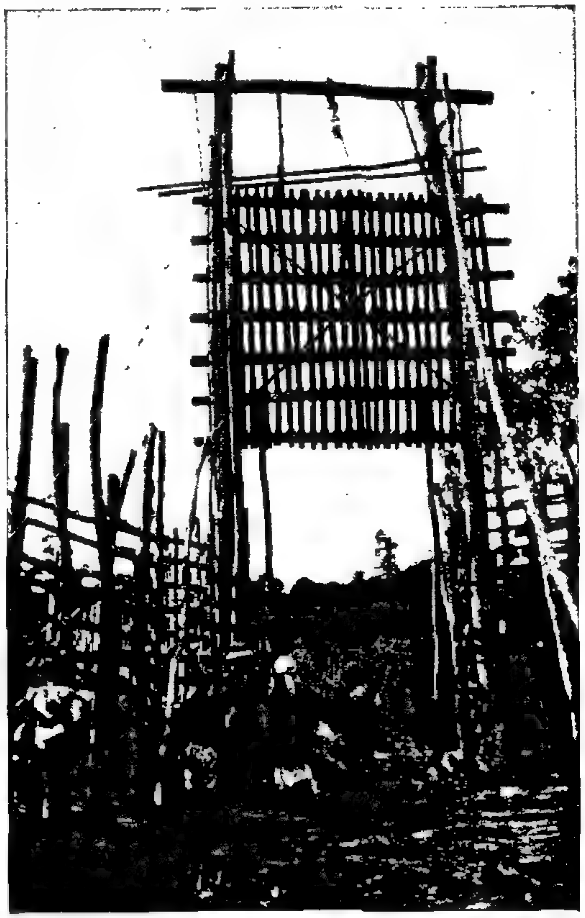
A *machan* is fixed up in a convenient tree on this line and a *gachua* (look-out) posted when the drive is on. When he signals that the elephants have crossed the *ber* line, it is rushed by parties from the ends of both the wing lines, and positions taken up along it to prevent the elephants breaking back.

When this line has been completed, the main body of drivers leave camp to commence driving the elephants. Their departure from camp is a very interesting ceremony, as they march in single file past the superintendent who takes their salute. The stockade and wing walls are then camouflaged with green branches by those who are to guard the lines. The gate is suspended, and sections are marked off along the wing lines and put in charge of *manjhis* who fix the position on their section which should be guarded. Scouts are thrown out ahead of the wing lines to give immediate information of the approach of the elephants and every arrangement made to take prompt advantage of the fact that the elephants have crossed the *ber* line. A party at least 20 strong is posted at each end of the wing lines, to rush it when the elephants have crossed.

The drivers send in a runner each day, with information regarding the movements of the elephants they are driving.

When the elephants get within 6 miles or so of the wing lines, the staff left in camp takes up its position on the wing lines; camouflaging that has dried is changed, and patrols are sent round by day and night to see that there is no talking and that fires are kept low.

As soon as the scouts thrown out come in with the news that the elephants are approaching the ends of the wing lines, the superintendent with the jamadar gets out to one end of the wing line, to take any action that is necessary to prevent the elephants getting away past the ends without alarming the elephants unduly.



The gateway complete.

The protecting ditch.

It often happens that the beaters have been unable to keep up with the elephants, who have moved off quickly when disturbed. This is a critical period, as a light screen of beaters has to be hurriedly rushed out from both ends of the wing lines to envelope the elephants, and the slightest mistake on the part of this party may stampede the herd for good and all. These men do not fire guns at the elephants, except in dire necessity; but gently urge them on towards the funnel enclosed by the wing walls by blowing on whistles made from bamboo.

It has been found by experience in Departmental operations that it is best for the superintendent to take personal charge of the second driving party in such a case as it inspires the men with confidence and enthusiasm.

Once the elephants are across the *ber* line, a sigh of relief goes up. If this occurs in the daytime, bamboo rattles, guns and bombs keep the elephants in the surround; if at night huge fires at every post keep the elephants off the line. Should they charge the line, they are greeted with a shower of hand bombs while the gun men near by blaze small shot at them as fast as *they can let off their guns.*

Driving the elephants into the stockade at night is not advisable inasmuch as one can't see very well in the dark or even in the moonlight in dense jungle and the men naturally funk it. The best time is just after dawn, as the elephants can then be driven in, in an hour's time, and everybody can see what they are doing.

Should the beaters not have come up during the night, the driving party has to be organised from the labour available. Here again it is advisable for any sahib on the spot to chip in. Not only is there plenty of excitement, but the scratch crowd collected can be led and encouraged to put their backs into it.

When the elephants are nearing the stockade it is advisable for the superintendent to leave the driving party to carry on, and follow the wing line down towards the gate quietly. The men who light the fire-lines wait for his order to light the stacks along the lines. A nice judgment is required in ordering these

to be lit. The men have a habit of shouting, "Allah Allah" while lighting the fire. This practice is objectionable as it attracts the notice of the elephants, and should there be a surly male or suspicious old cow in the herd, it will promptly charge. Should all the fires on one line not be lit, he will get through even should he fail to get the man, and the remainder of the herd will probably follow him.

It is advisable to have a few staunch men handy to rush the fire-line as soon as it is lit, and blaze away behind the elephants to get them on the run towards the stockade.

To facilitate keeping close behind the elephants narrow paths are cut from fire-line to fire-line. The gun men get the greatest fun but also incur the greatest danger. Cases are on record where part of the herd has broken back, being startled at something. In such a case the shelter of a big tree to stand behind, a cool head and a quick and sure aim are essential to get away with a whole skin.

When the gate falls behind the elephants who have entered the stockade, a bell is rung to inform the beaters of the fact that the gate is down, when they rush towards the gate to assist in getting props against it firmly fixed. The gun men promptly rush to the gate, and blaze into the ground to prevent the elephants from charging it.

It is advisable to keep both eyes and ears wide open when rushing to the gate, especially at night, as more often than not one or more elephants are left outside when the gate drops and these are so frightened with the fires and guns going off, that they rush about blindly in their anxiety to get away and the unwary run a great risk of being trampled on.

After the catch has been made, they are generally left in the stockade for 24 hours to cool down; unless a large number of elephants have been left outside, and are still in the surround. When this is the case time is money and *kunkis* are put promptly into the stockade, and the catch roped and taken out so that a fresh drive can be made to catch the balance. It is on record that a calf in the first catch was roped up and kept in

the *roomghar* (of which more anon), the gate was lifted up, camouflaging done, etc., and the calling of the calf for its mother induced the rest of the herd outside to walk into the stockade of their own accord when the gate was dropped behind them.

It sometimes happens that the number of *kunkis* on hand is too small to deal with the catch made, with a further lot in the surround. This entails wakeful nights on the part of those on guard and it is a nerve-racking business for those guarding the gate, as the part of the herd left outside try to get in, while those inside try to get out.

*(To be continued).*

## THE ORGANISATION OF THE FOREST ENGINEERING SERVICE.

Mr. Martin's article, which we published in the last number offers excellent advice in the matter of the organisation of our exploitation staff. So far the step taken to deal with this vital matter consists of appointing two American consulting engineers for a period of two years. About a dozen young engineers have been selected and trained in America for more than a year and they are now about to join the Forest Engineering Service in India. In many provinces special officers have been appointed to control departmental timber operations but their duties are usually limited to the felling, conversion and extraction of timber by existing methods. It is usually beyond their knowledge or function to introduce new or improved means of extraction and transport. Such work will fall within the province of the forest engineers. But we are somewhat astonished to see that our activities have stopped here. It is obvious that the engineers will not themselves be able to do all the work in connection with engineering projects. They will be controlling officers analogous to divisional forest officers and will require an organisation similar to the ordinary divisional staff to perform the actual work. It would not be economical to employ highly paid officers as the

executive staff where a cheaper indigenous agency will do equally well. Moreover the policy of training Indians for the higher posts must not be lost sight of. It will be necessary first to settle the various grades of establishment required. Mr. Martin has indicated the necessity for some uniformity in the status, responsibility and rate of pay of such establishment. It would obviously be advantageous to settle upon the organisation which will best meet general local conditions and then consider how the staff is to be recruited. Existing institutions can doubtless be made use of to supply a staff possessing the required technical qualifications as a basis on which to build the special knowledge and experience required for forest work. It is also a subject for consideration as to whether a special training in forest engineering should be super-imposed on the ordinary vocational training of existing engineering institutions. A year or two of theoretical and practical training in ordinary forest engineering seems to us a necessity. If this view is adopted the location of the training institution or institutions and the syllabus to be followed would be subject for consideration. It would probably be economical both in staff and equipment to centralise such training, although the practical work should be performed where projects of special utility to meet local requirements are actually in progress. It does not seem advisable to train the Burma staff in the Himalayan region or *vice versâ*. The theoretical course might therefore be centralised but the practical instruction could probably be located at several centres to meet the requirements of groups of provinces in which local conditions are analogous. This is a rough outline dealing with the executive or subordinate staff but it seems to us that an administrative authority to control the work is equally necessary. Nothing is so destructive of results as the isolation of experts. There must be liaison and co-ordination with the rest of the department while the methods employed and results achieved, whether successful or otherwise, should be made known to everyone. Local officers are usually too busy to communicate results in technical papers and, as often as not, do not realise the extreme value of the communication and interchange of ideas. It would

therefore seem that the administrative duties connected with the training of the staff, the organisation of the forest engineering staff, the scrutiny of projects and the analysis and publication of results will have to be done by administrative officers of the rank and status of Chief or Superintending Engineers. At the outset it would also be advantageous to create temporarily for five years a special appointment of Director to advise, from the Government stand-point, the professional administrative and controlling officers. Such a post could best be filled by a senior forest officer who has made a special study of exploitation. We consider this a necessity as our forest engineers, both in the controlling and administrative ranks, will require constant elucidation of the forest officer's view-point and of the limits within which conservative exploitation is permissible. There is a vast gap between our acceptance of permissible concentration of logging and the methods in use in those countries where mechanical and other means have been most developed. It will be necessary to bridge this gap, often in the form of compromise, but our fortunate inheritance and the work of past generations in creating our forest capital must not be left to the engineers to reduce or destroy. Close control and the formulation of a policy will be required at the outset, the more so as forests are now looked upon by many of our legislators as a means of producing additional revenues from a source which will not react directly on the masses.

We are not aware to what extent this subject has already received official consideration but we urge that no time be lost to organise ourselves so as to derive the utmost benefit from the staff of experts who are being added to the Department.

## NOTE ON THE FUTURE POLICY TO BE ADOPTED IN FOREST UTILISATION.

For many years past there has been considerable controversy between the adherents of the system of selling standing timber to purchasers, and those who advocate the complete exploitation of timber from the forests by the sole agency of the Forest Department. In the Punjab, the pendulum has swung from the one system to the other with extraordinary frequency, to an extent indeed which has somewhat bewildered the unfortunate forest officer.

A recent adverse criticism of the results obtained by departmental working by a leading railway official seems to indicate the necessity for the adoption of a more definite policy than has hitherto been laid down.

The questions now to be decided are :—

(*i*) Is the Forest Department to undertake complete control of felling, converting and extracting its produce from the forests to the markets, or

(*ii*) Is it to employ completely or partially the agency of business firms for these purposes; in other words, will the employment of a middleman on any terms likely to prove acceptable to a reliable agency be profitable to Government?

In considering these questions, it is evident that two entirely distinct classes of work have to be dealt with, *viz* :—(*a*) Felling, extraction and transit ex-forest to sale depôts, and (*b*) the disposal of the raw product delivered in depôt, to the best advantage.

Judging by past experience there appears to be no doubt but that the middleman has been too expensive and Government has not always hitherto received a fair proportion of the value of its timber, of which by force of circumstances it virtually holds the monopoly of production. Moreover, it cannot be argued that, so far, agency firms have shown any marked activity either in the introduction of new species to markets or in the more economic extraction of species already known. It is true that it is only

since the war that these subjects have been seriously considered, but even so, the fact that in the Punjab, the antiquated methods of hand-sawing of valuable timbers such as deodar practised, result in a loss of some 55 per cent. of the entire volume of timber produced can hardly exonerate firms whose sole profession it is to market such produce, from the charge of lack of enterprise. Another argument in favour of working the forests departmentally is that experts skilled in the use of modern lumbering machinery *hardly exist in the country. The introduction of such is* expensive, and unless long leases, which are undesirable, are granted, cannot pay. There is yet another aspect of the question which has hitherto not become prominent. The time is now rapidly approaching when the forests will increasingly be called upon to produce raw material required for specific products for manufacture by firms who have specialised in the particular line: paper making, match making, and so forth.

Now the extraction of the raw material from the forest is a very troublesome business, and obviously such expert firms do not wish to be bothered with such work. All they wish is a guarantee of delivery of enough of the raw product at definite intervals to fulfil their requirements.

The main advantage of employing an agency firm for extraction appears to lie in the greater freedom it possesses as regards the appointment of its staff and obtaining stores, etc. If, however, Government is convinced that it can work its estate without paying an outside party to do so, those difficulties should not be insuperable. The solution appears to lie in the employment of experts in exploitation, for the next few years at any rate, on short term agreements (say up to five years) rather than by putting them directly into a permanent service. These men will complete the training of the exploitation staff now being partially trained in America.

A consideration of these facts appears to indicate that there will be three main agencies in the handling of forest produce, *viz*:—

(*i*) The agency of production itself, that is the Forest Department

(*ii*) The exploitation agency, to handle all produce ex-forest to sale depôt.

For the next few years *this should be treated as a pioneer industry* which, by the importation of trained experts and machinery, will gradually acquire a skilled local labour force. This work will at first remain in the hands of the Forest Department which will gradually hand over operations to trained employees as these become capable of undertaking the work on contract. Thus departmental work, pure and simple, may be regarded as a temporary phase necessary to put it on a sound basis.

(*iii*) The manufacture and disposal of the raw products.

This is clearly the point where management on purely business lines is a *sine quâ non*.

No forest man has any real experience of timber sales and classification. He does not know accurately either the market value of his commodity, or the form in which it is most saleable. Any reliable business firm does know this and can be of great assistance to Government in the disposal of its produce.

The handling of the raw product affords excellent opportunities for co-operation with expert firms. Every sale depôt would include up-to-date timber handling machinery, saw-mills and plant for dealing with by-products. These would be run on a profit-sharing basis jointly by Government and the firm, the business being managed by a Board of Directors consisting of, say—

(1) Development Commissioner *or* Chief Conservator of Forests ... ... President

(2) Utilisation Conservator of Forests (liaison officer between the producer and consumer).

(3) Depôt Forest Officer.

(4) (5) } Two representatives of the agency firm.

The firm would buy the raw product from the forest at a price at which the division would make a reasonable profit. The firm or Government or both would subscribe the necessary capital by mutual agreement. The Board of Directors of the company then formed would appoint the necessary staff, purchase all stores. Its accounts would be kept on business lines and audited by a firm of Chartered Accountants annually. An arrangement on these lines is a perfectly simple one. It is a purely commercial proposition, and is not complicated by questions of policy and so forth to the extent that work in the forest is. Work on these lines presents unlimited scope for enterprising firms, and at the same time provides Government with the means of obtaining a fair share of products of which it holds the monopoly of production.

It also avoids the pitfall of granting forest produce at "concession" rates, which merely result in loss of revenue to Government. Save in small quantities for experimental purposes, there is no point in giving away valuable raw material below its market value. Such products as paper pulp, match wood, and many others, are beyond the experimental stage. All that is necessary is to guarantee their regular supply in the quantities required for a sufficiently long period. If their manufacture is a good commercial proposition, firms will readily come in on a profit-sharing basis. If not, neither Government nor a firm will want to touch it.

J. W. A. GRIEVE,
*Chief Conservator of Forests, Punjab.*

# AFFORESTATION IN THE UNITED PROVINCES.

BY E. BENSKIN, M.A., I.F.S.

The object of this publication is to place on record the history of afforestation in the United Provinces and the events which led to its inauguration. The text gives a running account of the subject which occupies about one-quarter of the book, and the remainder is composed of extracts from various Gazetteers, reports, etc., etc., connected with the same subject. These appendices, though they fulfil a useful object, will not be read with such interest as the narrative.

The importance of forests in a country such as Northern India where every drop of available moisture is needed, where a heavy monsoon falling on mighty mountains causes devastating floods and still more devastating erosion, a country where numberless ravines are rapidly decreasing the area suitable for cultivation, reducing the places affected to an indescribable wilderness, is well brought out both by the numerous excellent photographs and by the interesting narrative.

Starting with a short essay on the physical and economic importance of forests, Mr. Benskin proceeds to show how the effect of disforestation turned a fertile land into the present desert of Sahara and, coming nearer home, how, within the memory of living residents, the slopes near Mussoorie, once covered with dense oak forests, are now entirely denuded of their crop over large areas and how the accumulated effect of flooding, caused by the lack of forest in the Himalayas, has lowered the bed of the Jumna at Etawah 60 feet in the last 500 years, with a corresponding sinking in the spring level.

He then outlines the policy, past and present, regarding afforestation with a history of the work. He goes on to give an account of the actual methods and species used and finishes with an essay on the financial aspects. Last but not least is a useful list of relevant literature.

The book is recommended to all forest officers and the Government of the United Provinces are to be congratulated on

such very excellent work and on adopting such a far-seeing policy.

It is bound in what would be an attractive manner, the size is convenient and an improvement on many Government publications. But why, oh why is such excellent work spoiled by the very cheap and nasty meterials used? The photos are well printed but the paper for the text leaves a certain amount to be desired, the printing is not of the best and the binding is extremely bad. Both copies we have received are already falling to pieces, leaves are coming out and the book will need rebinding if it is to be a permanent record. In a recent working plan issued in the same form we have noticed the same defect. Surely such work deserves to be recorded in a more fitting manner.

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# INDIAN FORESTER

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## FOREST MANAGEMENT.

" Every tree whether isolated or forming part of a canopied crop is a living entity possessing an individual existence. Its species, condition, age, habit, situation, and countless other details combine to make it a tree different from all others.

" The conditions favourable to growth and maximum development vary not only with every species but also with individuals of the same species and these conditions differ for every tree in accordance with the state of the individual and its environment, so that the task of the silviculturist too varies with every tree that he has to deal with.

" Forest management is also necessarily varied according to the forest concerned. All points of difference have therefore to be noted and indicated, after the general rules applicable have been laid down. Every forest offers a real and living individuality. It differs from every other forest by its situation, its aspect and configuration ; by its soil, by its component crops and also by the character of the surrounding country. There are

no two forests any more than two towns exactly alike and it would be a great mistake to suppose that the management of forests adjoining each other or situated in the same region can be built up on the same frame-work or pattern. The forester labouring under so erroneous an impression would lack the very fundamental idea that should guide him, and instead of adapting himself to circumstances would vainly endeavour to force circumstances to suit his silly imaginings.

"The great dangers to be avoided in forest management are preconceived ideas and foregone conclusions. Every rigid system refusing to yield to the varying requirement of different forests and localities must be equally vicious, and more than this it must infallibly result in its slaves overlooking some important facts, and indispensable conditions. Indeed it is this very danger of carrying into effect preconceived opinions that justifies us in warning the forester against seeking any perfect solution of the problem before him, the realisation of some impossible ideal, and in advising him to confine himself to doing his best to obtain the results required and no more. If, imbued with this spirit, he knows the forest he is dealing with, is careful to conform to the essential rules of forest management, and allows himself to be guided by the true principles of silviculture, by endeavouring to obtain from well constituted crops and promising trees only such products as the soil can yield, he will scarcely ever fail to draw up a good working plan."

The above masterly exposition of the guiding principles of forest management written by Charles Broillard in 1860 may be taken as the text on which this essay has been written. The article has been prepared mainly to meet the wishes of the Honorary Editor of the *Indian Forester* who has asked for a discussion of the principles of forest management enunciated in Mr. Robbins' admirable essay on forest management in Switzerland, which appeared in the July issue. I shall try to show that silviculture and forest management in India, at any rate in the most enlightened divisions, are in no way inferior to any continental practice; that the working plans branch of the United

Provinces has no preconceived ideas of management and is ready to adopt any silvicultural system and any method of calculating the yield which promises to give the best results under any given set of conditions; even to evolve new silvicultural systems in order to meet the peculiar characteristics of a tree, such as *sal*, which differs from any species found in Europe by the peculiarity of its reproduction and early development.

While admitting all the errors of the past and acknowledging the excellence of a true selection system with certain species and under certain sets of circumstances, examples of which we already have in India in Kulu for *deodar*, spruce and silver fir; in Chakrata for *Quercus incana* and in Kheri for *sal*; I shall endeavour to show that a "return to nature" as adumbrated by Dr. Gayer and his school of forestry does not necessarily mean a return to the selection system; that a primeval forest of spruce and silver fir, let alone woods of pine, have none of the characteristics of the ideal selection wood. Further for many species treatment under selection principles is absolutely opposed to the fundamental silvicultural characteristics of the tree and any system of management which does not provide for optimum silvicultural conditions throughout the life of the tree has nothing to recommend it and is bad forestry.

Present day thought in Switzerland appears to have little regard for the Saxon system of clear felling and planting. Under certain sets of circumstances it still remains far and away the best method of treatment. Who would recommend a system of natural regeneration by compartments or management under selection rules in the case of British woodlands managed for pit props on a rotation of 60 years? Again is it possible to recommend any method superior to the clear felling and planting of teak in Nilambur or the clear felling with natural regeneration of *sal* in Gorakhpur? Even this the most artificial of all methods still remains under certain circumstances the superior of any.

The most wonderful results have been obtained with the shelterwood compartment, or uniform system, both in Europe and in India. It may be stated without fear of contradiction that

nothing finer than the regeneration of oak and beech in the Spessart, of *chir* in Kumaun and *deodar* and *kail* in Kulu can be obtained under any other system of management. Present experiments with *sal* indicate that the best method of regenerating this species will probably be under a shelterwood. There is no comparison between the regeneration of *deodar* under a light canopy of mother trees and under ordinary selection conditions. The management of even aged woods is infinitely easier than that of uneven-aged stands, exploitation is simplified and in certain cases the financial results are better. Such being the case what possible object would be obtained by attempting to convert even-aged stands to irregular woods? In my opinion it would be madness to attempt such a proceeding. The uniform system is admirably suited to certain species and to certain conditions and has only been adopted under such circumstances. It fulfils the silvicultural requirements of the trees both as regards their reproduction and growth and admits of an exact calculation of the yield. Where forests are burdened with grazing rights this system permits of the closing of the area under concentrated regeneration. Where very extensive areas are under management the concentration of the regeneration is of enormous benefit and means that these areas can be given adequate attention, whereas under selection conditions the mere fact of the vastness of the charge meant that nothing whatever was done to tend such reproduction, nor was the executive officer in any way responsible for obtaining adequate regeneration as he is under a periodic block system.

In previous articles in the *Indian Forester* the advantages of a periodic block system over the up-to-date selection system for hill *sal*, propounded in Mr. Smythies' article in the August 1930 number, has been well brought out and need not be repeated.

To turn now to the discussion of the selection system: Mr. Robbins shows that the original selection system in Switzerland consisted in the removal of the best trees. This is exactly what has happened in India, working plans have confined themselves to fixing a diameter limit, called the exploitable size, and to calculating the number of trees to be felled by a mathematical formula

based on a fallacy. Such management equally ended in disaster both in Switzerland and India but the Swiss apparently realised this a long time before we did. Having tried clear felling and planting they have now found salvation in an enlightened selection system which they are in process of adopting on a considerable scale on the plea that this consists of a "return to nature." Are they not perhaps following another whim of fashion?; at any rate let us not fall into the error of preconceived ideas and foregone conclusions, but keeping an absolutely open and impartial mind consider the management of every forest on its merits. However super-excellent one method may be in one locality with certain species and under certain fixed conditions we should not rush to try and reproduce such a system with different species and under totally different fixed conditions.

The cry of the return to nature as applied to the "Method of Control," if by this is meant a return to the theoretical selection forest, is a worthless argument. The silviculture of the method is quite good enough to justify this system of management without such a catchword which will not impress anyone who has any knowledge of the characteristics of the virgin forest.

The untouched primeval forest hardly exists now in Europe and it is necessary to go to America or Asia to find virgin stands of coniferous trees. As the Swiss are dealing with conifers we will confine our observations to the virgin fir forests of the Himalayas which are the same to-day as they have always been. They consist of a dense stand of mature mixed spruce and silver fir to pure silver fir, the trees are of various diameters and no doubt of varying age but of equal height growth. Reproduction of spruce is entirely absent, that of silver fir sporadic. Suppressed silver fir only 20 feet in height have been found to exceed 40 years in age. There is neither a normal distribution of age classes nor a normal reproduction, and after a final thinning in such woods the stand has all the appearance of even-aged high forest. The soil is covered with a dense layer of undecomposed humus, inimical to reproduction, and ordinary selection fellings do not produce the conditions necessary to coniferous reproduction, more especially

in the case of the spruce. It has been proved in Kulu that to obtain natural regeneration of spruce a uniform seeding felling is required and only under these conditions has any reproduction worth the name been obtained. The reproduction of *deodar* obtained under selection conditions is very inferior both in quantity and quality to the masses of young growth obtained under the management now in force. Again in the case of pines the natural forest resembles that found under uniform management far more than the selection wood. I have seen untouched forest of *Pinus longifolia* which looked exactly as if it had been given a seeding felling.

The selection system may at times in the case of a dense shade bearer, like beech or silver fir, more nearly correspond to what occurs in nature but this is not so with other species. The shelterwood compartment system corresponds better to what is found under natural conditions in the case of the pines. In order to obtain satisfactory conditions under selection treatment, with most species the theory that the stand should contain on every acre trees of every age class from one year seedlings to mature trees has to be considerably modified in practice. In order to obtain reproduction and maintain this in health the fellings tend more and more to group fellings. These groups with the increase of their area tend more and more to develop into small even-aged stands and produce trees having the characteristics of such stands rather than of trees grown in an uneven aged forest. This treatment is actually prescribed in the case of *deodar*, oak and *sal* managed under proper selection plans, as without such groups proper development and growth is not obtained.

All the authorities admit that the tendency of selection worked forests is to approach more and more to the condition of even-aged high forest, and that the maintenance of a state of irregularity is exceedingly difficult. In order to maintain ideal selection conditions even in the case of silver fir, man has to be constantly struggling against this natural tendency towards regularity, opposing his will to forces stronger than himself, and instead of following and directing the tendencies of nature endeavouring to thwart her wishes.

*The selection system now working in Kulu and shortly to be* introduced elsewhere makes no attempt to thwart this natural tendency towards regularity but, allowing nature to have full play, encourages her leanings towards regularity, anticipating that when the time is ripe an alteration in the present management from irregular to regular high forest will be both necessary and desirable.

It has therefore been shown that neither in nature nor in art *is the selection system Nature's System any more than regular* high forest, and the fallacy of describing selection management as a "return to nature" has been clearly proved.

In my opinion nature employs as many silvicultural systems as man and it is in adapting man's practice to the natural requirements of the tree that success in silviculture lies.

The advantages and disadvantages of the selection system are summed up in Hawley's "Practice of Silviculture" as follows :—

"The selection method with its uneven-aged form of forest stands in sharp contrast to the other three previously considered. For this reason it is to be expected that definite arguments in favour of and against can be presented.

"*Advantages.*—1. Affords a high degree of protection to the site and to reproduction and minimises the danger of snow-slides and land-slides. The forest canopy is kept nearly complete, the openings made being small and scattered. No other method *affords such perfect protection* against erosion, injury to the physical factors of the site and against the development of a grass and weed cover. Seedlings receive shelter from sun, wind and early and late frosts. The continuous cover of trees of all ages presents a strong mechanical barrier to the progress of land and snow-slides. Such slides rarely, if ever, start in a selection forest.

2. Can be applied extensively where markets are poor and only trees of large size are merchantable. Poor market conditions *hamper the full development of the selection idea, but do not* prevent the partial use of the method, for even with the poorest markets it is the largest trees that are saleable.

3. The method best satisfies the æsthetic purpose, due to its picturesque uneven-aged form, and avoidance of anything approaching clean cutting.

4. Windfall is eliminated or reduced to a small figure in selection forests. The individual trees have the opportunity to develop large crowns, compared to trees in even-aged stands, and become windfirm. The small trees are well sheltered by the older ones.

5. Reproduction is relatively easy to secure, due to an abundance of seed trees and to the protection afforded to the seed-bed and seedlings.

6. The selection method is the only one which maintains the uneven-aged form of forest.

7. There is less danger of disastrous fire than in forests of even-aged stands in which the solid blocks of reproduction create enormous fire hazard. In case fire does occur seed trees are always present to stock up the burned area.

8. An ideal method for the small farm woodlot, because it permits annual or frequent harvesting of large timber. Such a woodlot (of five acres for example) is too small to be effectively organised for annual or short period yield on a clear cutting or shelterwood method.

*Disadvantages.*—1. Since the mature trees are scattered throughout the whole stand and are intermixed with reproduction and small trees, logging costs more than under other methods.

2. Due to the mixture of age classes it is difficult to prevent in the logging injury to the immature trees which form the forest capital.

3. Grazing cannot be permitted since reproduction is in progress continually.

4. The timber produced averages lower in grade than that grown in even-aged stands. It is more apt to be knotty due to the greater crown development of the individual tree. To some extent the site on which the selection method is ordinarily employed accounts for this. Selection forest has been used principally on poor sites in exposed positions and at high elevations as a

protective forest. On such situations the timber produced under any method is of lower quality than that produced on better sites.

5. To apply intensively requires great skill on the part of the forester. This results from the complex nature of the age distribution in the stand."

The author also deals with the controversy as to the relative productivity of the selection and other systems. The Swiss foresters argue that the principle of the maximum sustained annual yield is compatible with the selection system and Biolley claims to have proved that this is so for the forests of the Canton of Neuchatel. Broillard on the other hand writes:—

"The outturn of produce of a forest worked by selection is acre for acre, admittedly less than that of a regular high forest. This inferiority is due principally to the languid growth of some of the trees and the sickly condition of a much larger number, and is very marked or insignificant according to the state of the forest concerned. The quality of the produce yielded is also inferior, sometimes even absolutely bad. The chief causes of this inferiority are (*i*) the rapid growth of the bigger trees, which in the case of conifers produces soft grained timber; (*ii*) the formation of large knots, which are serious defects when they occur in the silver and spruce firs; (*iii*) the production of various kinds of unsoundness which induce rapid decay in the wood of the species just named. These defects, like the general unsatisfactory condition of the crops, result from the exploitations being spread over too large an area. The consequence is that the damage caused by the felling and export operations is not confined to one locality (in which case it might be easy to repair or mitigate), the commission of all kinds of offences is rendered easy, and the trees that stand out isolated above their neighbours, having their crown exposed to the full force of the wind, are thereby broken, uprooted or shaken. Nevertheless, the worst that can be said of silver fir forests worked judiciously by selection is that they are not regular."

The independent American authority already quoted sums up as follows:—

"Whether the method gives a lower increment than other methods of high forest has been a point of controversy abroad for

many years. Some authors contend that the greater the area of foliage per tree and the more complete use of available nutrients, resulting from the mixing of young and old trees with root-systems penetrating to different depths, must work for greater production under the selection method.' The argument against this is that the retardation of the growth of young and middle aged trees, through shading by older ones, more than offsets these items. It is not until the last half of the rotation that trees in a selection stand are completely freed from shading by taller trees. Analyses of the growth of individual trees show marked contrasts between those grown in even-aged stands.

Much of the difference in opinion as to the relative production of even-aged and uneven-aged stands arises from unfair comparisons between the two. To gauge the relative production of two methods the same intensity of application must be employed in the management and the two stands must be on the same quality of site. When these conditions are met the production of even-aged and uneven-aged stands should be equal."

Before proceeding further it may be well to state again that forest management is neither dominated by silviculture nor by the requirements of exploitation and the tendency of extremists of both schools is to be resisted. Good management consists in a compromise of all the factors of silviculture, exploitation, staff and labour, rights and local requirements existing in the area at the time of the compilation of the working plan. It has lately been suggested that every consideration should give way to that of lumbering on American lines and it has been calmly proposed to clear fell and plant whole valleys of spruce and silver fir when it is well known that a shelterwood is almost imperative for the latter species. Such proposals are absolutely opposed to the school of thought enunciated in this paper.

To turn now to a detailed consideration of the latter day development of the selection system in Northern India.

The theory is well described in the Ramnagar Working Plan dealing with the Selection Working Circle for *sal* and its associated species.

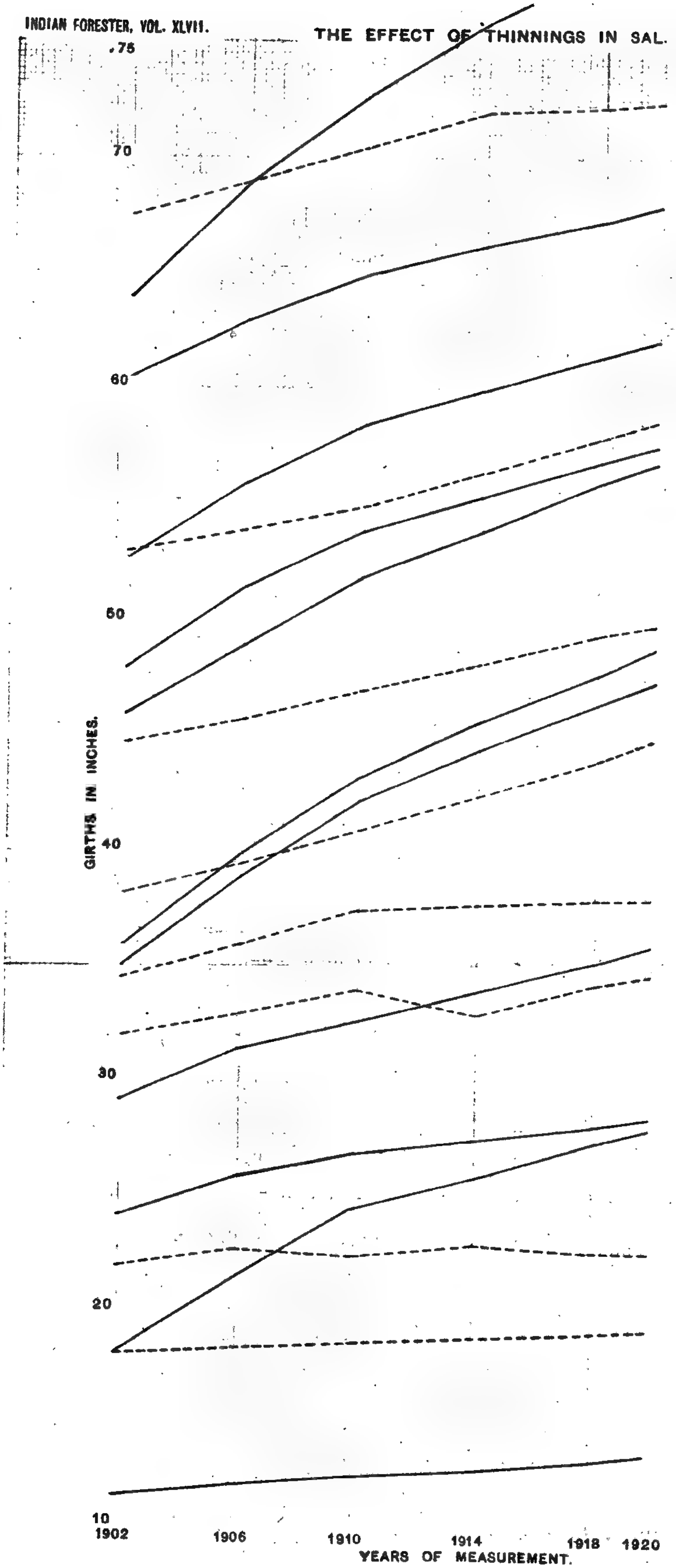
"The fundamental silvicultural idea is a normal series of age classes, mixed in groups of sufficient size; each species growing on the locality most suited to it. Pure *sal* is not aimed at; good *bakli* or *sain* is to be preferred to bad *sal*.

The object of the fellings is to realise the mature crop of trees and at the same time improve the general condition of the growing stock and complete natural regeneration.

The selection fellings to be carried out will consist therefore in every compartment of a series of all silvicultural operations necessary to health, growth and regeneration."

To take another example we will turn to the Selection Working Circle of the Kulu plan.

"These forests will be worked on the selection system, that is to say, the felling of trees will be so arranged that, while providing for the necessary reproduction, attempt will be made to bring the forests into a more normal condition than they now present. The old system of dealing with selection forests in India has been abandoned: the yield is calculated in volume and the sequence of felling is not rigidly prescribed, the object being that the fellings in this circle may be made to fit in with fellings which may be going on in neighbouring compartments of the Regular or Fir circles. Owing to the characteristics of the *deodar* the felling of single trees would not be followed by reproduction, and consequently selection in groups will be adopted. It is also permissible to make a regeneration felling over a limited area should this appear desirable. Trees of any size may be felled in accordance with the silvicultural requirements of the crop, and the volume of all deodar trees of 12" diameter and over will count against the prescribed yield. When any compartment is being worked thinnings will also be made where necessary. All species other than deodar are auxiliary species in this circle, they may be felled as silviculturally desirable either in the interests of deodar or their own reproduction. The growing stock of auxiliary species has not been ascertained, and the volume of such trees felled will not count against the prescribed annual yield which consists solely of *deodar*."




*Note how effect of the thinning tends to wear off after 10 years, but has had a marked effect on girth increment in that time.*

*E. A. Smythies.*

*Continuous line = thinned plot.*
*Broken line = unthinned plot.*

Photo. Zinco. August, 1920.—No.3388-856.

The oak forests of Chakrata Cantonment are also to be worked on a similar rational system with a complete enumeration and calculation of the yield in volume.

The "Method of Control" as described by Mr. Robbins only differs from the above examples in that the yield of every compartment is separately considered on the basis of the current increment, the increment per cent. and the distribution of the age classes, such detail is impossible at present under Indian conditions.

The yield of the Kulu Selection Working Circle is calculated on a complete enumeration with Hufnagel's formula checked with the actual current annual increment. Heyer's method is being employed for the calculation of the yield in the Chakrata Cantonment plan and Howard's modification of Von Mantel's formula in Kheri.

To show that we are not biassed in favour of the periodic block system with a calculation of the yield by volume and area, I would instance the Ranikhet Chir Working Circle and the Lansdowne Working Circle where Heyer's method is used for forests managed under the Uniform System. Clear felling for *sal*, with natural regeneration and a yield by area, is being worked in Gorakhpur with most excellent results and a similar modified system, where an over-wood is retained for a short time primarily as a frost protection wood, is being elaborated elsewhere. All these examples show that while perfectly willing to learn from any source we shall continue to follow the priceless maxims of Broillard and avoid preconceived ideas and foregone conclusions, basing our forest management on the true principles of the silviculture of the tree with which we are dealing in its special environment and by the requirements of the local conditions and circumstances of every wood, adopting that system which is practicable under the various fixed circumstances that arise and which is calculated to produce the best financial results in consonance with the fundamental rules of forest management.

C. G. TREVOR.

## KHEDDAHS IN CHITTAGONG DISTRICT.

[*Continued.*]

The roping-up process when seen for the first time is fascinating in the extreme. Before this can be done a *roomghar* has usually to be built. This is done by enclosing a certain space from the gate and between the wing walls, by an additional cross wall, and further strengthening the wing walls, as the catch has to be tied up in the *roomghar*, before removal to the *pilkhana* (elephant standing). Every alternate series of posts in this structure has to be three-ply, to prevent the elephants pulling it down when tied to it. The larger elephants must invariably be tied to the three-ply posts.

When the *roomghar* is ready, a section is opened out, just wide enough for the *kunkis* to pass through.

To watch a *kunki* wrap her trunk round a post, firmly embedded in the ground, and pull it out as easily as you would a cork out of a bottle, conveys some idea of the enormous strength possessed by an elephant.

When the elephants have passed into the *roomghar*, the section is again tied up as firmly as before, and men with spears and guns take up a position there to prevent any elephant breaking through should it charge this section.

The *kunkis* may then either go into the stockade, the gate being lifted up to enable them to do so, or work in the *roomghar* which is done by turning their backs to the stockade when the gate is lifted, the mahouts concealing themselves as much as possible by lying well forward on the elephant's necks.

In the former case the *kunkis* go in, turning round with their backs to the wild ones when they approach them, the mahouts keeping their spear points towards the wild ones, in case one or other of them gets aggressive. Should one of the wild ones put its trunk along a *kunki's* back towards the mahout he promptly gives it a prod with his spear. This causes a general shoving about but they soon settle down. The mahouts now gradually

move their elephants about, so as to detach one of the wild ones from the herd, and get it jammed between two tame ones who keep tail on to the wild ones. When this is done one of the mahouts gives over his *kunki* to his mate, who shins up by the trunk or is given a lift up by the *kunki* lifting a foreleg, and slides to the ground getting behind the wild elephant that is to be roped. A *partalla* is first tied, hobbling the hind legs together, care being taken to keep out of reach of cow kicks, which would kill a man quite easily, and to work silently. It is amazing to watch how quietly the wild elephant will stand as a rule and allow its hind legs to be hobbled. After this has been done *dols* or *phans* are fixed on to the hind legs, one or both hind legs being tied according as the elephant is medium or large sized. These are passed along to men outside the stockade, who pass them round three posts, after which the *kunkis* shove the wild one about till it is pushed backward so close to the stockade that the hind legs are tied practically tight up against the posts.

After this one or two nooses called *phans* are thrown over the neck and are so fixed with a thinner rope, called a *sori*, that the elephant cannot be strangled. These neck ropes are also tied to the stockade. When dealing with large elephants nooses are put round the front feet as well and tied to the stockade. The whole herd is thus treated, and when all the larger ones have been tied up, the smaller are only noosed and a *sori* fixed, after which they are roped to *kunkis*. There is a special way of attaching the *dol* or *phan* which ties a wild one to a *kunki* so as to permit of the *kunki* using its greatest strength with the least likelihood of rope gall.

Other *kunkis* then tie up to the bigger elephants, the number of *kunkis* tied on to each wild one depending upon its size. When they are all ready to march, the section referred to before is again opened out and the band plays. The wild ones resent being roped, and a series of tugs-of-war commence. The smaller elephants have no chance as the *kunkis* haul them along unconcernedly. Being hauled on their sides for a few yards, or with their heads rubbing the earth soon cures the youngsters of any foolishness.

One of the four firelines.

The "*kunkis*" at work.

The others give more trouble and often a tremendous fight is waged before the wild one decides to be sensible.

The large elephants never have less than two *kunkis* on, for should the wild one attempt to charge the one leading it, the *kunki* behind, which holds one of the ropes tied on the hind legs, promptly takes a strain in the opposite direction, and stops this little game.

It is as well to have a *kunki* spare, as appearances are apt to be deceptive, both as regards the strength of the individual *kunkis* and of the catch. The writer has had experience of a 7′—0″ *sarin*, dragging an 8′—3″ *kunki* all over the place from 11 A.M. to 4 P.M. when another *kunki* arrived and saved the situation. The fault no doubt lay a good deal with the mahout of the *kunki*, who got wind up badly, as the *sarin* fought more like a fighting ram than an elephant, and made repeated attempts to pull him off the *kunki*. She would have succeeded eventually, had we not got at her with spears, and distracted her attention when things were getting really bad.

It often happens that the *kunkis* are unable to remove the roped-up catch in one day. Should others have to be left roped up in the stockade, it is advisable to examine the ropes thoroughly, before getting off to camp, as, should one get loose it will bite through the ropes of the others, setting them free when the whole process of tying up has to be repeated next day.

Skimping work in building the *roomghar* also leads to trouble, as the writer had the experience of a 9′—4″ *makna* left tied in the *roomghar*, breaking all his ropes, except one leg rope at 8. P.M. with the result that he had to sit up on the stockade wall with a rifle while messengers raced to bring the *kunkis* from camp. Fortunately *chara* was available in abundance, and the *makna* continued to feed quietly, though he could have made a clean get-away by exerting a little further effort.

When the elephants are tied up in the *roomghar* and not in the stockade, the procedure is exactly the same as has been described. This method is used only when the catch outnumbers the *kunkis* and has to be dealt with in sections, *i.e.*, when a certain number of

the wild ones walk into or are persuaded into the *roomghar*, the gate being dropped behind them, and they are roped up; the process being repeated till the whole catch has been dealt with.

The wild ones are induced to come into the *roomghar*, by throwing *chara* plentifully into it, and disturbing them in the stockade, by shouting at them or firing a gun in the air, when they are gradually forced in the required direction.

After the elephants have been removed to the first *pilkhana* which is close to the kheddah camp, they are numbered and a sale list prepared. Care should be taken to see that all the good elephants are not bunched together in the sale list as this affects prices when auctioned.

From the *pilkhana*, the elephants are marched up by gradual stages to the auction mart, and there disposed of. These marches should not be too long, and should be made in the cool of the mornings, and evenings, as the elephants are very susceptible to heat.

*Mela shikar.*—Mela shikar was done for the first time in these parts in recent times, by Government, the writer being in charge of operations. The task of surrounding the herd was rendered comparatively easy, by the existence of a *dhala* path. Paths connecting one village with another through the Government Reserves are locally known as *dhala* paths.

As a *bangri* effort had just been concluded and information had been brought that a herd of elephants had crossed the Inoni *dhala* path and were in a block surrounded by paddy fields on the other three sides, we promptly took advantage of this and rushed the *dhala* path, posting men along it at intervals of 20—30 yards, to prevent the elephants breaking back, thus cutting off about 15-20 elephants.

On the next day information was brought that another herd of about the same number were south of the position we had taken up. As we had thoroughly surrounded the first lot by this time by placing posts all round the area, drivers were sent out to drive this lot northwards, and across the line held, while the men on the line were warned to get up trees, and let the driven elephants pas through.

Everything went like clock-work till the driven elephants were within 50 yards of the line. The wind blowing from south to north caused the lot inside the surround to wind the advancing elephants, and they commenced to come along on to the line also.

Fortunately, a calf amongst the lot inside gave the game away, so we pressed the lot coming up from the south herd, getting them across when we could hear the crashing of the jungle made by the advance of the other herd, hastening their movements by loosing off a few bombs behind them.

One man on a tree had a narrow escape, as he tried to signal that four of the elephants being driven were attempting to get away by another path. A tusker spotted him and charged the tree butting at it twice.

A small party of gunmen were fortunately on the spot, and greeted him with a fusilade, turning this lot back into the surround when the whole line was re-established as before.

During the night other small herds came along prowling round our camp, which was south of the line held, so we spent rather a wakeful night, lighting huge fires to keep them away.

The men on the line were inclined to be jumpy, having elephants in front and behind them, so the Sahib in camp had to sleep on the line, to put heart into them. There wasn't much sleep to be had, as alarms were rather frequent, and despite all attempts we could not induce those outside to get over the line and inside the surround, and on the next day again the work of building the stockade commenced. This stockade was different to the others being an eleven-sided figure 165 feet in circumference.

The next two days we spent wandering around inside the surround, and getting the lie of the land. We heard elephants close to us but did not see any, as the area surrounded was 3 to 4 miles square, and there were plenty of shady spots for the elephants to hang out in without coming out near the stockade.

On the next day as the wing walls had been marked out and were being built we marked out the right and left wing lines to reduce the area over which the drive had to be made.

On the next day again we took the right line. The elephants were on the right of the right line, and had to be driven across it. The first herd went over quite easily, but the second gave a lot of trouble as the big tusker in this herd did not like being hustled at all. At one time we thought that the driving party after this herd were after a single tusker, locally known as a *goonda*. But when our best shikari sent us information that there were at least another ten elephants with him, we chipped in, and a little pressing brought them over.

After crossing this herd over, we held the right line. The next day we started to take the left line, and had a series of exciting moments. When the drive began, we found that one herd was standing near the wing walls. The other was on the left of the left wing wall, but scattered and we knew nothing about them till we bumped right into them. On getting the information of the first herd I had arranged flanking parties, one along each wall, to envelope the herd and drive them in, taking charge of the left flanking party myself. My party, which was to go along the left wing wall, had barely left the stockade when I heard the elephants crashing about in front of us. Telling the main body to make a detour, and join up with the right flanking party, and then with me at the end of the left wing wall, I crept forward. The party had hardly branched off, the last man just disappearing in the jungle, when there was a tremendous demonstration—smashing of jungle and shrill trumpetings.

I was standing by the stockade wall, trying to locate things exactly, when an old cow with rather a biggish calf dashed out of the jungle nearly on top of us. It took me a matter of a few seconds to take a dive through the fencing of the wing wall, and one of my baboos who was with me, the unfortunate possessor of a pronounced waist line, followed me with equal celerity, but with a great deal more discomfort. The other man simply vanished till he was found later in camp graphically describing his narrow escape and was made to feel rather sorry for himself.

The cow (*dhui*) had not spotted us, and got rather a nasty jar when she was greeted with two charges of shot making her

"For sale."

The result of one of the drives.

vanish with more speed than dignity. The shot scared the lot standing near the wing walls and it was some little time before we could collect the flanking party again. After collecting them we carried on with the drive over the left line.

Things were going swimmingly and one small batch of eight elephants was nearly over the line, when a further *contretemps* occurred. One of the beaters had crawled close up to this lot, and loosed off twice in the air, instead of letting them have it in their tails. With an empty gun in his hands, his heart failed him, so he started to climb a tree. Had he stood still, the elephants would not have spotted him, but his movements betrayed his whereabouts, and an old tusker followed by the remainder started to get back. We were concealed behind big trees, within 30 yards of the elephants, so chipped in, firing into the ground in front of them. At this the tusker deliberately charged; taking three bullets in the head which caused him to swerve and he broke right back as the beaters all promptly took to trees.

This meant sending the beaters right back to the line at which they were very sore. We went back to the stockade and started to drive again. G——who was hoping he was for an off day, happened to meet the Jamadar in charge of the driving party, as he was returning to camp from the *pilkhana*. Seeing that the Jamadar had wind up badly, he came along and helped and the elephants crossed the left line like lambs, the tusker giving us no further trouble.

After this the left line was manned.

The next day driving operations commenced, this being done by villagers who were frightfully keen to have a go at the elephants as they had done considerable damage to their crops in the past. Four drives in all were made resulting in the capture of 19 elephants. The smallness of the catches was due to the beaters not keeping in line, and to the fact that all drivers were untrained men.

During the drives there were several exciting episodes, one being when a herd led by a tusker charged the stockade wall, and were stopped at the wall by shots being fired at them.

Another time the gate was dropped behind four elephants, and eight others came right up to the gate, with the beaters hard on their tracks. The beaters were drawn across, standing shoulder to shoulder, from wing wall to wing wall, and kept bombing and shooting at the elephants every time they attempted to break back. We at the gate did the same every time they came near the gate. The noise of the guns, bombs going off and people shouting was so great, that this state of things was not realised at first. When we did see what was happening we had literally to haul the beaters out, as their blood was up, and not knowing the gate was down, they were determined not to let the elephants break back.

The day before the last catch of two was made, we had a sad accident, one of the mahouts, the best man we had, having his thigh smashed by one of the captures, a *makna* getting his elephant a lunging blow with his tusk.

The venture closed with a total capture of 33 elephants, the operations covering a period of three months.

In conclusion I might add that a Kheddah is the most fascinating and interesting work one can be put on to, providing many thrills, which one can ruminate over till the next season comes round.

That danger exists cannot be denied, but this can be reduced to a minimum, by keeping a cool head combined with quick and accurate shooting when required.

There are few things that give the sportsman better satisfaction than tackling and slaying a rogue elephant that has terrorised defenceless villagers, and who will generally be found to be a coward at heart, when stood up to, as most bullies are.

Nothing else can give that thrill of pride that comes when a satisfactory catch is marched out of the Kheddah Camp, on the way to the sale mart to be disposed of.

M. A. T. MARCHANT.

# THE FINANCING OF CENTRALISED RESEARCH AND EDUCATION.

In our review of the proposals for the training of probationers for the Imperial and Provincial Services it was stated that Local Governments would in future be expected to pay the cost of the education at the proposed centre to be established at Dehra Dun. Apparently the Imperial Government would find the money to cover the initial cost of land, buildings, etc., and would charge interest on this outlay, as well as all expenses connected with the staff, maintenance, etc. This matter is now under consideration by Local Governments.

Obviously the Government of India, which only has direct control over the forests of Coorg, the Andamans, and Baluchistan, intends to assume the part of sponsor for the higher educational requirements of Local Governments but the latter will bear the cost. It has struck us that, in view of the very small financial interests which the central government has in the results of research, it would be equally justifiable to apply the same principle to the financing of the central research institute. Originally the Government of India received, as contributions to its exchequer, a part of the provincial forest revenues but forest revenues were wholly provincialised in 1911. From that time the Government of India has met all the costs of education and research incurred at or through Dehra Dun. In adopting the system of recovering its outlay in one direction the Government of India might usefully consider the propriety of recovering the whole.

The cost of erecting new research and educational buildings on a scale commensurate with the interests at stake will cost a good deal of money, which it must be difficult to find from current revenues. It would be preferable to find the capital for this expenditure from a loan, the interest on which would be charged to provincial revenues. To the latter would be added the estimated cost of the staff and other expenditure and the total would represent the sum of the contributions to be made from provincial forest budgets. Readjustments could be made periodically, say

after every five or ten years, and there should be no lapses. Savings, if any, would be carried forward. We are not attempting to work out a scheme but merely to set down a few ideas.

The present position is as follows :—

The Research Institute and College are under the control of the Inspector-General of Forests who exercises the authority of a Local Government over its affairs, but with the important distinction that having no funds whatever at his disposal it is necessary to address the Government of India in the Revenue and Agriculture Department in all matters requiring increased expenditure. That department deals with all forest matters but is also without funds and therefore refers to the Finance Department who, having to meet our demands from sources wholly unconnected with the objects of the expenditure, naturally has difficulties to meet all calls and scrutinises expenditure very closely. If the provincial contributions were in the hands of the Revenue and Agriculture Department much saving of time and trouble would result.

It may be objected that the earmarking of funds in advance in this way would be objectionable but provincial contributions could be made quarterly or half-yearly so as to create a minimum of inconvenience. At all events forest research and education could in this way be financed from provincial forest revenues and there would develop gradually a distinct relation between the work of the central institution and local requirements. This relation at present exists in theory and is exercised through the Board of Forestry which meets every third year and advises on the programme of research and on such matters of general administration as are laid before it. The delay in circulating questions of policy to local governments is however so great that in at least one instance complete replies to the recommendations made at one meeting had not been received before the next sitting of the Board three years later. Obviously a strong administrative council is required with authority to introduce necessary changes at once, subject to the general control of the Government of India in the Revenue and Agriculture Department. Such a council could be composed of the heads of the department in the different

provinces and of the Research Institute and College and should meet at least once a year. Its functions should extend to control over all matters connected with research, education and finance within the periodic allotments. This administrative body could perhaps usefully be broken up into committees each dealing with one of the above subjects and only matters of general policy would require the consideration of the whole body. It is doubtful if the Board of Forestry as now composed would then be required. It has served its purpose in establishing liaison between the central institute and the provinces, but if higher authority is given to the proposed council it would no longer be necessary as an advisory body. The technical part of its work is already fully met by the sectional conferences which have now been inaugurated.

We have strayed somewhat from the original subject of our theme but the method of finance proposed would postulate the creation of a governing authority representative of local interests. The two are interdependent and inseparable. We have had sufficient experience of a purely advisory board to know that without administrative authority its achievements are negligible. Given an assurance as to funds and power to direct the methods of their disposal the proposed council would ensure the direction of our research and education into the most profitable channels.

It is not of material importance whether provincial contributions bear a particular relation to the gross or net revenues of a province, although we should prefer the former, but it is of vital importance that we should know that our programme of research can be carried out over a definite period of years and that we should be freed from the constant dread of our budgets being pruned down to the averages of the past three years or curtailed by considerations having no connection whatever with our 'raison d'être,' which is to develop the forest resources and forest revenues of the country.

There may be unforeseen difficulties in placing the Government of India in the position of a trustee over funds voted periodically by local legislatures and it may be that the latter would require guarantees or safeguards but the provincial representative,

backed by the views of a forest committee of the local legislative council could voice the local stand-point in the administrative body. As we have already stated we are not endeavouring to work out the scheme but we feel that if all difficulties can be overcome and our proposals adopted the tax-payer would benefit enormously, not only in the more rapid development of our resources, but by the assurance that forest education and research bear a more correct relation to the interests of the country as a whole than can be the case under existing conditions.

# BARK-BEETLES OF THE GENUS SPHÆROTRYPES.

BY C. F. C. BEESON, FOREST ZOOLOGIST.

In " Indian Forest Insects," pp. 476—496, an account is given of the life-histories and economic importance of six species of the bark-beetle genus *Sphærotrypes* (family Scolytidæ), *viz.*, *siwalikensis*, Steb.; *assamensis*, Steb.; *globulus*, Blandf.; *coimbatorensis*, Steb.; *querci*, Steb; and *macmahoni*, Steb.

These insects were considered to be pests of primary importance, particularly in sal forests, where their habits were studied by Stebbing.

Investigations have been carried out in recent years on the borers of sal and its associates in natural forest, and incidentally the life-histories of the species of *Sphærotrypes* have been under observation. Early in the course of the enquiry it became evident that considerable confusion existed as to the identity of the insects concerned. In 1915* the writer pointed out that *assamensis*, Steb., should be considered as a synonym of *siwalikensis*, Steb. In 1919 he came to the conclusion that *coimbatorensis*, Steb. was a synonym of *globulus*, Blandf. At the same time it was discovered that *macmahoni*, Steb., was not a *Sphærotrypes*, and that *Chramesus globulus*, Steb., described on p. 498 of Indian Forest Insects, should be transferred from *Chramesus* (a genus confined to America) to *Sphærotrypes*. When on leave in 1920 the writer discussed the matter with

* Beeson (1915), *Indian Forester*, XLI, pp. 296-297.

Colonel Winn-Sampson (who is preparing the Fauna of India volume on Scolytidæ), and a revision of the genus was arranged.

It is proposed to publish eventually in the from of a Forest Record, the results of the work done on the systematic and ecological sides, but in the meantime a summary of the principal conclusions is issued in the hope that specimens and observations will be collected by forest officers, particularly of the species occurring in Himalayan oaks.

As the departmental literature in its present confused state is not only misleading to the divisional officer who may wish to consult it, but also contains inaccuracies, the following corrected synonomy and distribution of the genus is provided :—

## SYNONOMY OF THE INDIAN SPECIES OF SPHÆROTRYPES.

### SPHÆROTRYPES SIWALIKENSIS, *Steb.* (1906).

*Sphærotrypes siwalikensis*, Stebbing (1906) Dept. Notes, 3, pp. 389—394, Pl. XXIII, fig. 1, 1*a*—*c*; (1908) Ind. For. Mem., Zool. Ser., I i, p. 3; (1908) Ind. For. Leaflets, Zool. Ser., I, 8 pp., figs. 1—3; (1914) Ind. For. Ins., pp. 476—481, figs. 310, 314—315 and fig. 321 [=*globulus* Stebbing *nec* Blandford]. Beeson (1915) Ind. Forester, XLI, pp. 296—297; (1917) Ind. For. Rec., VI i, p. 3.

*Sphærotrypes assamensis*, Stebbing (1907) Ind. For. Bull. 11, pp. 23—28, Pl. V, figs. 5, 5*a*—*d*; (1908) Ind. For. Mem., Zool. Ser., I i, pp. 4—5; (1914) Ind. For. Ins., pp. 481—487, fig. 318.

*Sphærotrypes* sp. Stebbing (1907) Ind. For. Bull. 11, p. 28.

DISTRIBUTION: Dehra Dun, Lansdowne, Ramnagar, Pilibhit, N. Kheri, Gonda, Gorakhpur, U. P.; Jalpaiguri, Buxa, Tista, Bengal; Goalpara, Lakhimpur, Assam; Katha, Burma; Singbhum, Porohat, Bihar and Orissa; S. Mandla, C. P.

TREES ATTACKED: *Shorea assamica, Shorea robusta.*

### SPHÆROTRYPES GLOBULUS, *Blandf.* (1894).

*Sphærotrypes globulus*, Blandford (1894) Trans. Ent. Soc., Lond. p. 63. Stebbing (1909) Ind. For. Mem., Zool. Ser., I, p. 4; (1914) Ind. For. Ins., pp. 487—490 *partim*, Pl. XLIII, XLV [*non* fig. 321 = *Siwalikensis.*]

*Sphærotrypes coimbatorensis*, Stebbing (1906) Dept. Notes, 3, pp. 395—399, Pl. XIII, figs. 2, 2*a*, *b*; (1908) Ind. For. Mem., Zool. Ser., I i, p. 4; (1914) Ind. For. Ins., pp. 490—493, figs. 322, 323.

DISTRIBUTION : Dehra Dun, Lansdowne, U. P.; Buxa, Bengal ; Mandla, C. P. ; Belgaum ; Kanara, Bombay ; N. Coimbatore, Madras.

TREES ATTACKED : *Anogeissus latifolia, Lagerstrœmia parviflora, Shorea robusta, Terminalia tomentosa.*

*SPHŒTRORYPES TECTUS*, Winn-Samps. (*in litt.*) nom. nov.

*Chramesus* sp. Stebbing (1906) Dept. Notes, 3, pp. 409 410, Pl. XXII, fig 8.

*Chramesus globulus*, Stebbing (1909) Ind. For. Rec., II i, pp. 21—22, Pl. VI, figs. 4, 4*a* ; (1914) Ind. For. Ins., p. 498, Pl XLV, figs. 4, 4*a*.

DISTRIBUTION : Chakrata, W. Almora, U. P.

TREES ATTACKED : *Quercus incana.*

SPHAEROTRYPES QUERCI, *Stebbing* (1908).

*Sphærotrypes querci*, Stebbing (1908) Ind. For. Mem., Zool. Ser., I i, p. 5 ; (1909) Ind. For. Rec., II i, pp. 19—21, Pl. VI, figs. 1, 2, 2*a*, 3 ; (1914) Ind. For. Ins., pp. 492—494, Pl. XLV, figs. 1, 2, 2*a*, 3.

There is no type of this species in existence and no specimens in the Research Institute collection, except some *siwalikensis* presumably labelled *querci* in error. Colonel Winn-Sampson is inclined to conclude from the figures and descriptions that it is identical with the Japanese *pila*, but the writer considers that Stebbing confused his specimens of *querci* and *Chramesus globulus* as he says of the latter " the insect bores straight through the bark and into the sapwood and then turns to one side or the other and carries its gallery right down into the heartwood at an angle "— an impossible habit in a *Sphærotrypes*. The gallery of the shot-hole borer assigned by Stebbing to his *C. globulus* was probably that of *Crossotarsus fairmairei*, but that he was dealing with at least one species of *Sphærotrypes* in ban oak is evident from his figure of the brood pattern (1914) Pl. XLV, fig. (3). Specimens of oak bark-beetles are desired to settle this point.

SPHÆROTRYPES MACMAHONI, *Steb.* (1909).

This species is a variety of *Hylesinus cingulatus*, Blandford, first found in Japan.

ECONOMIC IMPORTANCE OF THE GROUP.

As mentioned above Stebbing considered this group of bark-beetles to be important pests of the trees in which they breed.

Of *siwalikensis* he expresses the opinion (1914, p. 479) that if there is a scarcity of sickly or newly-felled trees and the insect is in great abundance,

" it will attack healthy green trees "............" Serious attacks of the insect will be found to commence at a centre and spread concentrically outwards. There can be little doubt that this beetle may prove a source of serious damage to coppice coupes, if it once becomes numerous in adjacent areas of high forest undergoing improvement by the removal of all stagheaded, deformed and sickly trees. As the older areas become cleaner the issuing swarms of bark-borers would be forced to attack the green trees. It is more than probable that coppice areas would be chosen. The attack would be certain to begin in patches, the insect working outwards from a centre. Under *assamensis* (*loc. cit.* p. 484 he notes that "this bark-borer must be ranked as second only to *Hoplocerambyx* in its power of committing damage in the sal areas "............" In addition to attacking sickly standing trees in the forest it also makes attempts on healthy green standing trees.......Trees which had successfully resisted a bad attack by the February generation were succumbing to that of the May one."

If Stebbing's interpretation of the economic status of the sal bark-beetles is correct, it is remarkable that during the past six or seven years no cases of serious damage have been recorded, and no evidence is forthcoming to support the supposition of their primary importance. On the other hand the data available to the writer indicated that the better known species *siwalikensis* and *globulus* are secondary bark-beetles, whose normal habitat is in dead trees or in trees that are being killed by other factors.

The bark-beetles suffer in competition with other bark-breeding species (*e.g.*, longicorns and buprestids) and are usually confined to the upper parts of the bole and the smaller branch wood. Although somewhat selective as regards the degree of freshness in their choice of bark for oviposition, they appear to find most suitable conditions in the lop and top of felling areas and in winter wind-falls.

The inability of the sal bark-beetles to increase to epidemic incidence and develop mass-attacks on healthy trees was illustrated in conditions observed in Bengal in 1914-15, and throughout the course of a *Hoplocerambyx* epidemic in the United Provinces in 1916—1921. In the former case an enumeration of the dying sal trees attacked by *Polyporus shoreæ* revealed *Sphærotrypes* in only 13 per cent.; and in the second case not a single sal tree has been recorded as killed by *Sphærotrypes*. The rôle

of *siwalikensis* in young sal woods has been studied in Gorakhpur Division, U. P., and no positive evidence has been obtained of its ability to increase in large clear-felling areas and subsequently attack coppice growth. Suspected cases of deaths in sal pole coppice were found to have occurred before the advent of the bark-beetles.

Recent work on the seasonal history of *siwalikensis* shows that Stebbing's conception of five well-marked generations, following at regular intervals through the year, should be replaced by two main flight periods made up of overlapping broods of inseparable generations, in which the swarm period of a brood may occupy a longer time than the minimum life-cycles of two generations.

It is hoped in view of the necessity of establishing the economic position of common and presumably well-known forest insects, that records of cases in which fatal attack is assigned to bark-beetles will be communicated to the Research Institute. Records of the occurrence of *Sphærotrypes* (substantiated by specimens) in divisions not mentioned in this note are also desired.

## PADDING.

In response to "Junior's" letter in the June *Indian Forester* herewith a few shikar yarns to help to fill up. If the Editor doesn't want padding they will doubtless find their way to the editorial waste paper basket.

The following series of incidents all happened at the same place, which, in case others should be tempted to try their luck there in vain, may be called Kyunbinsu. It is a small station on the railway line in the middle of a Forest Reserve and the entire settlement other than the station buildings consists of the Forest Bungalow, the houses of the Forest Ranger and his subordinates and a few temporary huts used by people engaged in timber extraction. It was a place of some interest from a Forester's point of view and on one occasion a party of visitors consisted of the Inspector-General of Forests, the Chief Conservator and your humble servant. We were inspecting various matters of interest when we were attracted by loud and continuous roaring of wild elephants. We made our way to the place whence all the noise was coming and creeping up we saw through the jungle several elephants. At first they did not get our wind and we watched them for some little time. They seemed to be very busy tearing up something. Presently they got a slight whiff of our scent and closed up and we then saw quite a good tusker with the herd. The herd almost immediately took alarm and cleared off into thicker jungle. When we went up to the spot we found the ground all round had been considerably disturbed and looking round the Ranger suddenly saw a newly born baby elephant lying on its side. He pulled its ear and it squealed but lay

Officers keep tally of the amounts at their credit in the Treasury by means of a small sum in subtraction on the back of each counterfoil in their cheque books. This form might easily be abolished and another column added to the register of cheques called "Balance." Each entry in this column would show the balance in the Treasury immediately after the issue of each cheque and would show at a glance how much was available; annas and pies might perhaps be omitted.

Sums credited in the quarterly letters of credit would of course be added from time to time. Another source of complication and additional work in accounts is due to the multitude of heads of service. It is suggested that these might be reduced with advantage. All the sub-heads under revenue might well be abolished leaving only the major heads. Of course in special cases such as supply of fodder for war or famine purposes a separate account would as usual be kept. Similarly under expenditure all sub-heads down to A-VI might be merged into the main heads. Under A-VII, Roads and Bridges might be kept distinct from Buildings and Wells, etc., retaining only two heads. Charges for repairs and carriages of tools, etc., should more logically be debited to the works for which they were used. Under A-VIII, four heads would suffice. Demarcation should be clubbed with settlement and survey, the other three being Working Plans, Plantations and Protection from fire.

Sub-heads could also be dispensed with under A-IX. In short thirteen heads of service might well replace double that number of sub-heads. Similar doubling up could also be done with the establishment charges.

It is unfortunate that Forest Officers are not more generally consulted before the issue of new Codes for their convenience. The present volume under review would be infinitely more useful if it embraced the rules and forms now used in the collection of revenue with the details of which Audit Officers do not concern themselves. Curiously enough nothing is said as to the control of revenue in Chapter IX of this volume which is headed—"Conservators control over accounts." It is optional for Local

still. Then we all went up and patted it just to be able to say we had patted a wild elephant calf. Colonel Evans in his "Treatise on Elephants" says that a newly born calf lies from one to two hours after birth after which it can get on its legs and walk, so it will be realised how soon we had arrived after the event. The after-birth was also quite fresh and this was apparently what the elephants had been tearing up as it was strewn all over the ground. Colonel Evans says elephants usually eat the after-birth and it is possible that this is what was happening, but it was certainly not only the cow that was doing this, as I distinctly remember a young tusker was very busy tearing up what must have been the after-birth.

In the meantime while we were all looking at the calf, the mother was making a tremendous noise in the jungle about a couple of hundred yards away and I have never understood why the elephants forsook the calf without any offensive action. If I had been alone I should very much have liked to climb a tree near by and wait for further events but the burrasahibs thought they would leave. It was nearly breakfast time and the humble Divisional Forest Officer had to go too. The Ranger afterwards visited the spot and found the herd had come back and taken the calf away.

On another occasion I was out after elephants as they had been doing a certain amount of damage to young plantations and I wanted to drive them away. The Ranger was with me. Towards dusk we came on to the herd strung out in line in bamboo forest feeding. Getting round to an open space on the leeward side, we started to go along the line to try and find the tusker. We had not got very far and had seen no sign of a tusker when the elephants started moving out into the open. We had to get back into better cover and get behind an enormous teak tree. The elephants came on to where we had been standing where they must have got our scent as they all bolted down wind in our direction. Two cows and a calf ran past one side of the tree I was standing behind and I retreated to the other side and nearly ran into another cow that passed only a yard or so from me. By now it was getting dark so we had to give up the chase

and had quite an anxious walk in the dark with elephants on all sides of us which we could only hear but not see.

Tigers and bison were plentiful as well as elephants and I arrived by train one day to hear that a sambhar had been killed by a tiger within 300 yards of the railway station and only about 50 yards from the railway line. The sambhar had of course been taken away by the villagers and eaten, but I managed to get the skin and head and put them back in the place of the kill. I sat up over it that night and the tiger came about 10 o'clock and I bagged it.

I had another adventure with a tiger at Kyunbinsu but the tiger got off. One day I had hit a sambhar rather far back. I knew it had been badly hit but there was no blood trail and the ground was too hard to track. I got out dogs to try and follow but they could not get any scent. On the following day I was just going to start some girdling. I got to the starting point just near a small stream and went down into the stream to see if I could find any tracks of game. The first thing I saw was my sambhar lying dead in the stream. It had been hit far back in the stomach and had died when it drank. Moreover a tiger had just commenced feeding on it. I was looking round at the tracks and trying to see which way the tiger had gone when I noticed my dog was very nervous and looking down the stream I saw the tiger jump across and disappear into the jungle. I had a machan built and sat up that night. It was pitch dark and so I tied up a hurricane lamp. There was a high bank on one side of the stream with a bush overhanging a pool beyond which the sambhar was lying. The bush was the only place to tie the lamp on. I hoped the tiger would come along the stream but unfortunately he came to the bank and apparently did not like the light at all. I could just make out the white marks on the face and hear him snarling at the lamp. It seemed hours while he hesitated on the bank but finally he went down and started wading through the pool. My patience was exhausted and I let him have it as he waded but fired too high and missed him clean. Of course he was off like a flash.

With bison I never had any luck but on one occasion a friend had come up to shoot and I was up before dawn to see him off and see that the only shikari available, a Forest Guard, was ready. As I was up I thought I might as well go out too so I went off alone. I very soon came on fresh tracks of a decent bull and followed them up into an area of tall grass which had been burnt during the hot weather. There were large patches of unburnt grass and in one of these I heard the bison breathing heavily. It was quite impossible to see him so I tried to climb a small tree near, hoping to get a shot at him from above. By bad luck just as I was firmly wedged in a fork the bison jumped up and bolted. I followed him into some very dense evergreen jungle and was tracking him when suddenly I saw him standing a little way on. Unfortunately at that moment he thought it was time to go and I missed him clean. The moral is that when you are tracking it is better to have a man with you. It is very difficult to keep your attention on the tracks and at the same time be on the look out for the quarry to see it at the first possible moment.

I once entertained two ladies at Kyunbinsu for a shoot and found the experience nerve-racking. One morning I went out with one of them after elephant and can't say how thankful I was when we found they had moved to a distant part of the jungle. Coming back we came on fresh tracks of a bison, so marking it down we came back to camp and I took the other lady out after it in the evening. We came up to it at dusk. It was standing broadside on and gave a very nice shot. She fired and I also let it have it as it bolted. We heard it go off about 200 yards and then drop. However it was then nearly dark and I was not going to risk an encounter with a wounded bison in that company so we went home. Next morning I went out alone and found the bison dead where we had heard it fall.

Alas! the shooting at Kyunbinsu is no more. Instead of wild elephant and bison the whole place is full of extraction elephants and buffaloes and their wilder brethren have left. There are still tigers which occasionally take a buffalo but nothing

else to encourage a shikari. Let us hope that when extraction in this part of the forest is completed the elephant and bison may once more come to their own.

NGADAUK.

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THE "SYSTÈME HETZER" OF TIMBER LAMINATION.

A new method by which timber can be used in construction has been extensively developed in Switzerland by which large laminated girders are used taking spans on flat arches of far greater dimension than ever was used before in the case of timber. The new system is named after its inventor and is commonly known as the "SYSTÈME HETZER." The exact method by which the laminated beams are put together is not known, but it appears to be a combination of gluing and bolting, each laminated joint ending at a different point on the beam from the next. It is claimed by the inventors that this is the secret of the whole invention as no one portion of the beam is weaker than the other, which of course is the case when ordinary joints are introduced in common constructional work. It is also claimed that it is easier and also possible to estimate the static bending and compression forces in a built up beam more easily than it is in a solid beam and this too is probably a correct assumption as the inequalities in the timber which exist in a natural beam are overcome by introducing lamination in which the weaker portions are not confined to one locality. From the accounts given of this invention in Switzerland where this system of work was introduced in 1909-10 by Terner et Chopard, the system has very rapidly developed, and is now being extensively used and they claim that this is due to the above-mentioned factors of uniform strengths and the facility in calculating the exact mechanical strength of the laminated timber. The information which we have received on the subject has been supplied to us by Messrs. Terner et Chopard, Engineers of Zurich, with many illustrations of buildings constructed with laminated timber, which clearly denote the extensive use to which it is being put in Switzerland.

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R. S. P.

# LAYS OF THE WESTERN GHATS.

## IV.—CURRIED DUCK.

Hurrah ! for the end of the endless monsoon
How we've counted the weeks since the middle of June.
The tennis and dinners were all very fine
But life in a station is no love of mine.
Long-winded reports we have written galore,
Of office and budgets we're sick to the core
And it's time to be off to the jungles once more.

That khaki-clad fellow, so wise and discreet,
As sober a long-headed man as you'll meet,
You would think he contained all the cares of the state
But it's daft in the head he's been growing of late.
He shouts out his orders with laughter amain
As he routs out his rifles and lays down his pen,
For it's ho ! for the evergreen jungles again.

* * * *

When Christmas time comes in your home far away
And you draw round the fire from the darkening day,
Just gaze in the embers and shut your eyes tight
And a magical wand may transfigure the night.
For it's glorious to tread where the fairies have been
So flit o'er the ocean that stretches between
And look for a while on the tropical scene.

In a glade of the forest, all dewy and white,
The moonbeams fell soft on a wonderful sight :
On tree-stumps and branches, in fur and in feather
The Folk of the jungle were gathered together.
Red dogs and jackals and foxes were there,
Tiger and panther and bison and bear,
Snakes from the brushwood and fowls from the air.

Blue-bull and elephants, sambhur and boars,
Peafowl in dozens and cheetal in scores,
Muntjac and porcupine, all kinds of deer,
Graced the assembly with no sign of fear.
A troop of grey monkeys was leading the revels,
Altos and basses, contraltos and trebles
Dancing and whooping like so many devils.

Next came a sight that would startle the blind
And should serve an example to quarrelling mankind,
For the mighty assemblage of fur and of feather
Paired off and went dancing a two-step together--
But the climax was reached when an old Cockatoo
Inflated a bag-pipe of thorny bamboo
And they danced the Scotch reel until twenty past two.

Then a Great Tawny Owl with a hoot and a screech
Jumped up on a palm tree and made them a speech :
" Ladies and Gentlemen, " so he began,
" I'm delighted to see such a meet o' the clan
" Since the days when MacNoah his house-boat constructed
" I've not seen the fox-trot so gaily conducted.
" One parting injunction I beg to propose
" Look out, lest the elephant treads on your toes,
" For he's swallowed more palm-juice than any one knows.

" But before we disperse at the call of the sun
" There's a pleasureful duty remains to be done,
" For a Forester sleeps in his camp hard-by here
" Who has harried our jungles for many a year.
" What happier end to sae glorious a banquet
" (For which I should say Father Christmas be thankit)
" Than hurry and toss the auld fule in a blanket ? "

No sooner he'd spoken, the mighty troop filed
Away through the jungles so silent and wild,
Bird, beast and reptile, they uttered no sound
Till they circled the camp of the Forester round,
And then with a roar like the billowy deep
They roused the unfortunate wretch from his sleep
And heaved him aloft with a terrible sweep ! . . . .

And so he awoke—it was only a dream,
He had eaten too much curried duck, it would seem,
And lest such a fate should befall you as well
It were best the magician made off with his spell.
So hang up your stocking and blow out the light
Let Santa Claus fill it as full of delight
As the beasts of the forest that wonderful night.

GEM.